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The Conservation of Fuel.

With the domestic coal supply dwindling at the rate of 400,000,000 tons per year and the foreign supply disappearing at an equivalent rate, the problem of fuel supply takes on more than an academic interest. It is all very well profanely to enquire what posterity has done for us that we should forbear skinning the earth's resources on its account, but from the present outlook this matter has ceased to involve waiting for posterity. It has reached a point where there may be trouble within the lifetime of children now alive. If the coal consumption of the country increases at anything like the present rate it will probably not be more than a quarter of a century before the calamity of far dearer fuel will be upon us. It is not that the supply will be exhausted by then, but that scarcity, long transportation and deep mining will co-operate so to enhance the price of coal as to completely modify present conditions. The coal famine of a few years since shows the disastrous result of even a slight shortage in forcing up the price. What would be the industrial situation with steam coal at ten dollars and upwards per ton permanently? It is not a pleasant thing to contemplate and yet such is the situation which confronts us in the not distant future. It will not be long before most of the remaining coal will be low grade bituminous or lignite. A large part of the fields yet remaining untouched are, in fact, the meanest kind of lignite, entirely unsuited for transportation.

There is not enough wood left to cut any figure in the industrial situation. Of peat, good, bad and indifferent, there is a large amount, but thus far all attempts to get it into utilizable shape on a large scale have proved somewhat futile. The hydraulic power available at reasonable cost of utilization is being rapidly taken up. Even if ten million horse-power were in good shape for profitable development, it would at a rough approximation relieve the present coal consumption by only something like 10 per cent., while that consumption has risen 30 per cent. in less than five years. Hydraulic power, then, valuable as it is, can be regarded only as a small auxiliary. Is it not time for electrical engineers to make good their perennial bluff about distributing power from the coal mines? This proposition has been up for a long time, yet nothing substantial has been accomplished. Except for a plant in South Africa and one in Pennsylvania, there is as yet nothing like a serious power transmission from cheap coal. There is a vast amount of culm, lignite and such like stuff which cannot be profitably transported, but might be burned at the mouth of the mine with good economic results if the work were seriously undertaken. Most of it is so situated that it can be advantageously utilized in no other way, unless by the generation and transmission of fuel gas, which, again, is a scheme not yet seriously attempted from such sources of fuel. It is high time that progress were being made in these directions.

Of course there are difficulties at present in the way of burning lignite efficiently and on a large scale. Most boilers and furnaces are designed for use with fairly high-grade fuel, so that burning lignite involves special appliances. Yet there are indications that the problem of using lignite economically has been at least proximately solved. Certainly there are already in existence plants which do use it with pretty good results. It is sufficiently rich to do well once the art of burning it is mastered. With a big turbo-generator plant worked on such cheap fuel, power could be brought down to a point that would permit transmission over a long radius and sale at a good competitive figure, a figure, in fact, that would stagger a good many hydro-electric plants. Gas production and transmission under moderate pressure, as in the case of natural gas, would be also practicable in the case of some grades of poor fuel and would give the ability to furnish general heating as well as power. Heating is a terribly serious matter in our Northern climate, and if one relies on electrical heating the outlook is bad since the whole power of Niagara could not keep even New York City from freezing to death. When it comes to heating, in fact, there is not enough hydraulic power to be worth serious consideration. Fuel gas, however, can be made to help out very effectively and may come to be our chief reliance. The present outlook is grave, and it is time to be up and doing. Each year, with its increase of fuel consumption, brings down the current estimate of the endurance of the supply. Not long ago it was five hundred years, then two hundred and now practical exhaustion of the available supply seems a bare century off, with a serious increase of cost looming up in the near future. It is about time to start the fight to preserve the existing status of things lest the pressure on industry bring disaster. Even now there is a tendency to shift activity southward into a milder climate. Before things come to a serious pass it is well to try the virtues of power transmission from the mines.

Department Operating Costs in Industrial Service.

In manufacturing plants and public service corporations, operating costs must periodically be analyzed in minute detail for the most successful working of each property. To a large degree these questions are either concerned with technical matters or susceptible to engineering treatment as regards methods of investigation. As industrial development grows more complex, the distribution of departmental operating costs requires increasing skill in accounting, and the difficulties which stand in the way of accurate expense determinations in the different branches of an organization are by no means imaginary. Unless the cost of running each department can be determined with reasonable exactness, the best results cannot be assured. Thus, in a street railway system, it is desirable to know the operating expenses of different lines more closely than can be obtained by applying the average car mile cost for the entire system to the schedule of particular lines. The earnings of each line are readily separated in the total revenue, and if a close estimate of the cost of a particular schedule can be made for different lines, the service can be more nearly adjusted to the most economical car movement required to handle a given volume of traffic. In a manufacturing establishment, department costs carefully examined enable the course of production to be maintained with minimum waste at each step in the process.

The ordinary methods of accounting practised in large industrial organizations are frequently insufficient to show the costs of separate departments and in some instances nothing short of a special investigation will solve the problem. An example of this is found in the study which the Massachusetts Highway Commission has been making during the past year of the cost of telephone service in the Boston and suburban district. After about twelve months' investigation the Commission has reported the necessity of further analysis of the problem, and wisely so. The accounts of the New England Telephone & Telegraph Company cover the operation of local and toll service in several states, and the separation of operating expenses in a single metropolitan district with the object of finding whether the rates for suburban service are equitable or not is a technical and financial problem of the first magnitude. Engineering advice must be still more largely drawn upon before a sound decision can be reached in this case, even with the full cooperation of the company that has been accorded the Commission in the past.

Certain expenses peculiar to each department in a modern industrial organization can be itemized without much difficulty in the great majority of cases. Among these are the cost of labor, special materials and supplies. Joined to the record of production volume, they furnish valuable information as to a surplus or shortage of facilities in the handling of the stock at different stages, and economies can often be instituted on the basis of such data without the trouble of taking up the apportionment of expenses common to all or most departments. It is in dealing with the latter that scientific judgment finds full scope. Fixed charges can be obtained by careful figuring on the known costs of construction and equipment or upon the basis of appraisals by experts in the particular industry under consideration. The depreciation problem is obviously one requiring separation of values between the equipment of different departments. There remain such expenses as cost of power for department administration, selling costs, plant maintenance and general charges. It is not enough to figure the cost of generating each kilowatt-hour at the switchboard of the power plant and to apply that cost to the meter records of separate departments. A certain proportion of the fixed charges, maintenance and operating cost, including supervision, of the distribution system as well as the power plant must be apportioned among all power-using departments. Whether the apportionment of general charges is to be made on the basis of equivalent value, number of men on the department pay roll, volume of product handled in a specified time, rated horse-power of the machinery or other physical criteria can only be settled by special study of each case. The engineering department should usually be in position to assist in the preparation of pro-rating estimates on different bases, and to recommend, if desired, the character of physical data acceptable as the best means of approximating general costs of an indirect nature among different departments. It will frequently be possible for the engineers of a company to create short cut methods of recording essential cost data and to set in motion supplementary schemes to anticipate cost apportionments. Work of this character is valuable in connection with estimates of expansion cost no less than in relation to operating economy.

The Risks of Sewer Contracts.

It is often said by contractors for municipal works that there is no kind of such construction more likely to result in financial loss than sewerage contracts. There is often a good deal of uncertainty concerning the materials in which the trenches are dug and the unexpected presence of rock, water or quicksand may turn the anticipated profit into an actual loss. If it were practicable to draw up a form of contract that would provide for all such uncertainties and also be free from other objections, such a document would be a boon to both engineer and contractor. The attempted improvements along this line have so often resulted in introducing clauses productive of legal wrangling that there is a general tendency to-day to contract for a sewer of given size and materials at given line and grade, and let the contractor and city gamble as to which shall be the gainer and which the loser on account of the uncertainty regarding the actual character of the excavation to be done. Such a plan as this may work grave hardships on the contractor, however, unless he is careful to protect his interests in entering into supplementary contracts, as the following experience in a New Jersey town has shown.

A contractor agreed to lay about 2,900 ft. of 20-in. vitrified pipe sewer for $1.50 per foot at an average depth of 16 ft. in a locality supposed to be quite free from rock. This last assumption rendered apparently unimportant a provision that the "compensation for removing rock from the sewer and appurtenances must be included in the price per lineal foot of sewer or vertical foot of manholes" and also another provision that "no extra compensation will be allowed for tunneling." There was also the usual provision that the township engineer might make any changes in the line, grade, plan, position, dimensions or material of the work contemplated, either before or after construction had commenced. Subsequently the route was changed so that the length of the sewer was much shortened, the depth of the trench much increased, and a large amount of rock was encountered which made tunneling advisable. This work was done under a supplementary agreement by which the contractor consented to a change of the route of any part of the sewer mentioned in the original agreement. It further declared "that the terms, specifications, conditions and agreements in the original contract shall each of them in all respects apply to and be binding and operative upon the party of the first part (contractor) in the performance of all work and the furnishing of all materials rendered proper, requisite or necessary by any such change or changes of the route, and that in all respects, except as to such change of route, said contract shall be and remain in full force and virtue." It is self-evident to an engineer or contractor that a sewer constructed in a rock tunnel or in a rock trench cannot be built at $1.50 a foot, and it is almost inconceivable that a contractor should sign a contract and supplementary contract, as in this case, in which such a price was named. The contractor believed that as the original agreement did not contemplate any such construction as the change in route made necessary, he was entitled to reasonable compensation for the additional work. The town refused to pay more than $1.50 a foot and the contractor accordingly brought suit for a larger sum.

The Court of Errors and Appeals of New Jersey recently decided, 68 Atl. Rep. 160, that a larger sum was not due the contractor under the terms of the supplementary contract, and quotes as a precedent a decision made years ago in that State in which the law is interpreted as follows: "He that agrees to do an act should do it, unless absolutely impossible. He should provide against contingencies in his contract. Where one of two innocent parties must sustain a loss, the law casts it upon him who has agreed to sustain it, or rather the law leaves it where the agreement of the parties has put it. The law will not insert, for the benefit of one of the parties, by construction, an exception which the parties have not, either by design or neglect, inserted in their engagement." This decision regarding the interpretation of the original and supplementary agreements is probably what would be rendered in most State courts, and is particularly worth notice because it is directly opposite to the opinion of the United States Supreme Court in the famous case of Wood v. City of Fort Wayne, 7 Sup. Ct., 219. In the latter case the contract provided that the plans might be changed at any time, and that any extra work involved in such a change should be paid for at the agreed price for work of that class. The work to be done was pipe-laying across a river, and the original plans were changed by shifting the crossing from one street to another, where not only was the water 7 ft. deep instead of 2 ft. as at the original location but there was also a large amount of quicksand. The contractors refused to undertake the work on the altered plans until they were assured by the city authorities that they would be paid for the extra work. The authorities refused to live up to this assurance when final payment was claimed, but the Supreme Court made them do so, on the ground that there was nothing in the contract providing for payment for work done under the conditions actually encountered. This case was cited for the contractor in the New Jersey suit, but the Court of Errors and Appeals decided that it did not apply because the contract in the latter case said specifically that the compensation for all excavation must be included in the price per lineal foot of sewer. A consideration of these two cases will indicate the great desirability, on the score of equitable dealing, of having all such contracts drawn so as to eliminate controversies of the character that was developed in the suits mentioned.

The Philippine Railway System.

One of the most important works now in progress in the Philippines is the construction of railways, for it is the general belief of those who have made a close personal study of the resources of the islands that until railways have opened up at least a part of the best sections it will hardly be possible to demonstrate convincingly by accomplished results the great resources of the country. To-day lack of even fair means of communication is one of the most serious obstacles in the way of the rapid development of these resources in the most economical manner, for it is manifestly foolish to engage in any undertaking when the cost of transporting its products or the raw materials needed in it is uncertain and very high all the time. The railway systems now under construction deserve the attention of all who are interested in the welfare of these distant parts of the country, therefore, and they should be substantially encouraged by the authorities as being a great aid in the improvement of conditions which the government is pledged to ameliorate.

When the United States took over the control of the Philippines the only railway on the islands was a 120-mile narrow-gauge line between Manila and Dagupan. It was owned by a British company and was earning money, although the insurrection gave it a temporary setback. The country traversed is a rich agricultural section and as soon as conditions became settled two branch lines aggregating 80 miles were put under construction to reach fertile districts in the vicinity. When the government determined in 1905 to encourage railway development, this company held the key to the situation on the Island of Luzon, because the lines the government wished built were extensions or branches of those already constructed. The property was accordingly taken over by an American corporation, the Manila Railroad Co., of which the New York banking house of Speyer & Co. is the head. This company has received a franchise for the construction of 428 miles of road. The franchise is a perpetual one, but is not exclusive, and the government retains the right to regulate rates and is to be paid a percentage of the gross receipts. The company must complete 150 miles of road within two years of the time of finishing the surveys and 75 miles annually afterward. As soon as the franchise was granted, the general manager, Mr. Horace L. Higgins, an English engineer connected from the outset of its work with the old company, began the surveys and has since pushed the enterprise vigorously. Surveys have now been completed for about 240 miles of branches and extensions, and grading has been completed on about 100 miles of these lines. It is interesting to know, also, that the company is helping along the construction of good wagon roads which will serve as feeders to the railway and thus assist in opening up the rich agricultural and mineral resources of the island, long neglected on account of lack of means of transportation.

The railway work on Luzon is being done without any government guaranty of the interest on the bonds issued to pay for it, but such a guaranty is given by the government in the case of the 4 per cent. bonds of the Philippine Railway Co., which received concessions for about 95 miles of road on the Island of Panay, about 120 miles on the Island of Panay, and about 60 miles on the Island of Cebu with another optional route on that island. This company was organized through the efforts of Messrs. William Salomon, J. G. White, Charles M. Swift and several banking houses; Mr. Salomon is the syndicate manager and J. G. White & Co. are the contractors. The actual direction of the surveys and construction was intrusted to Mr. E. J. Beard, who has been urging them forward at a rapid rate. About 230 miles of line have been surveyed and preliminary surveys have been completed on a considerable additional mileage. Construction was begun on the Panay and Cebu lines in November, 1906, and has been carried ahead steadily since then. Thirty miles of the Cebu road were sufficiently completed last September to enable regular train service to be started and about 20 miles on Panay were ready for operation somewhat later. Additional rolling stock for these lines was ordered some time ago and train service is to be extended and improved just as rapidly as the construction work permits and equipment is delivered.

What these lines will mean to the people of the country they traverse can be understood from a consideration of present methods of transportation. Roads are generally very poor and the cost of moving freight over them by bullock carts is so high that about all the freight movement that amounts to anything has to be done by water, thus confining active development without the railways to the districts along the sea coast and the navigable rivers. The estimated cost of transportation by railway will be at least 30 per cent. lower than the present charges and in some cases as much as 60 per cent. This will be a boon to the poorer classes of people in many respects; for instance, rice valued at over half a million dollars was imported from China into Iloilo during the fiscal year ending June 30, 1906, although there was a large amount of better rice available in the Province of Capiz which could not be moved on account of lack of transportation. The more one looks into the situation the more evident it becomes that these roads literally mean "the Philippines for the Philippinos" and that their completion will mark the dawn of greatly improved conditions on the islands.

Notes and Comments.

THE WINDSOR LOCKS CANAL on the Connecticut River between Springfield and Hartford, is attracting some attention at the present time on account of its relations to a project for the improvement of the river for shipping purposes. It is interesting on account of the fact that while it was originally built for navigation it has become an exclusively power canal. It was constructed to enable boats to pass around what were known as the Enfield Falls, about 4 miles long and divided by nearly a mile of dead water into upper and lower falls of 10 and 20 ft. respectively. The total length of the canal is about 6 miles, its width is about 60 ft. and its depth 8 to 9 ft. It was opened late in November, 1829, and served its purposes for barges until the railroad between Springfield and Hartford was opened in 1845. Even before that time a few manufacturing establishments had been established between the canal and the river to utilize the fall of water from the former to the latter. After the railroad had checked the boating on the river, more manufacturers took advantage of this opportunity to secure cheap water power. As a result, all of the power which the canal can supply has long been in use and some of the establishments in the neighborhood of Windsor Locks have been obliged to put in steam auxiliaries. The company which owns the canal, known as the Connecticut River Co., is made up of stockholders who are interested in these manufacturing establishments, and it would appear that they do not look with special favor upon the loss of their water power which may result from the proposed improvements in the river. In case the water power is given up in whole or in part by the company, it will be interesting to learn what compensation it will receive for the rights surrendered.

THE MONOPOLY OF ELECTRIC SUPPLY by the imperial government of Germany which is now under discussion in that country is one of those socialistic proposals that fairly take away the breath of the average American citizen. Nobody seems to know just what is contemplated, further than the fact that the imperial revenues are proving sadly deficient for the demands made upon them and it has been suggested that a monopoly of the supply of electricity might be exercised in some way that will yield the necessary additional funds. Before such a proposal can reach the Reichstag it must be approved by the Bundesrat representing all the states in the empire, and as the Bundesrat has not yet taken up the subject it is evident that there is no prospect of any immediate shifting of the control of electric central stations. It hardly seems possible that those who suggest this step can appreciate the vast difference between a monopoly of electric current and the monopoly of customs, stamp duties and other sources of the present imperial revenues. Electric supply works are almost wholly local affairs and the proposition to place them under imperial control is a bolt out of the clear sky, for up to the present time it has been customary to suggest monopolies only in connection with purposes or products of general as distinct from local importance. A large proportion of the electric supply undertakings in the empire are owned by municipalities which will be reluctant to give them up, while another large proportion have been developed as important parts of great industrial plants, whose proprietors may be counted on to fight vigorously to prevent the loss of ownership and control of the great systems of electric supply and transmission specially designed and built for their peculiar needs.

AN INTERNATIONAL ENGINEERING WORK of much interest in connection with the proposed improvement of American water-ways is the improvement of the Sulina mouth of the Danube. In 1856 an international commission was authorized by the Treaty of Paris and charged with the duty of clearing the mouths of the Danube and neighboring parts of the Black Sea, which were unsafe for navigation on account of sandbars and shallows as well as pirates and wreckers. There are three arms of the delta and after careful study it was determined that the Sulina arm was best adapted for improvement. When the work was begun there was a bar across the mouth on which the depth of water was 8 to 11 ft., while the river itself was narrow and tortuous, with about 8 ft. of water at the best. Under the direction of Sir Charles Hartley, who was head of the engineering work from its inception until recently, jetties were run out across the bar at Sulina to 18 ft. depth of water and in a comparatively few years the river scoured out a 17-ft. channel between them. These works were maintained and extended during the following fifteen years but little else was done until about 1878, when improvements were started in the river itself which did away with a number of sharp bends and increased the minimum depth of water to 16 ft. Up to 1889 about $1,800,000 had been spent on the work. In that year comprehensive plans for giving a mean depth of 20½ ft. were adopted which called for some difficult construction in the way of channel embankments in marshes. These improvements have been carried out and as a result of them the Sulina arm has been reduced from 45 to 34 miles in length, 27 bends have been done away with, and the river has become one of the busiest streams in the world. Sulina, a wretched hamlet of huts in 1856, is now a town of 5,000 population with about twenty floating elevators for handling grain, and quays, landing stages and other facilities required for the rapidly growing commerce of the wheat-producing districts of the Danube.

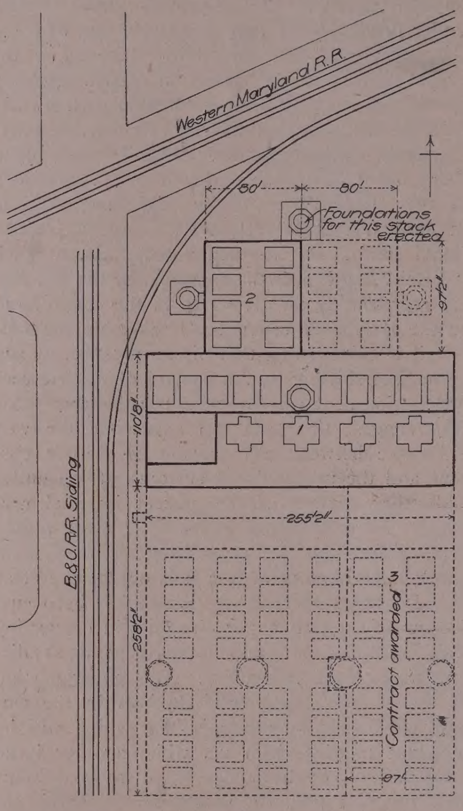
THE NATIONAL CEMENT USERS' ASSOCIATION held a convention last week at Buffalo which was one of the most successful gatherings of an industrial character of the winter. Not only was the attendance large and the interest in the papers and exhibits lively, but the Association was able to do good missionary work with the local authorities who have heretofore not been inclined to adopt building regulations permitting all the legitimate uses of concrete which modern engineering has developed. At Buffalo as at Chicago last year, the exhibits proved of marked educational importance; people did not look at them as they look at animals in a menagerie, but carefully and with the manifest intention to learn just what concrete could be used for in their own work. The papers and informal discussions were of a good character and wide range and were all of the practical character that is so desirable at such meetings. There are plenty of societies established many years where the theoretical problems connected with the design of concrete structures may be properly discussed, but the National Cement Users' Association is distinctly the organization where the designer and builder, the manufacturer and user of concrete machinery, the engineer and contractor have the best opportunity to get together and compare notes for their mutual benefit. Up to the present time the Association has been run largely by the voluntary services of a number of men identified prominently with the concrete industry, and the success that has attended their efforts is an indication of the field which the Association may occupy if its members choose. It is unreasonable to expect, however, that the men who have given their time and money freely in the past to put the organization on its feet, should continue to do so. This was recognized at the convention last week and steps were taken by which certain classes of manufacturers who gain most by progress in the use of concrete are to contribute more toward the funds than the regular members who often find the expenses of attendance about all they can afford. The great usefulness of the Association is in the education of these men who are doing relatively small work but hope to extend their contracting field as they gain experience and knowledge. There is an enormous amount of small work done annually in the way of sidewalks, walls, gutters and curbs, water basins, and small buildings, and the fact that a good deal of it has been and still is being done poorly is a distinct menace to the progress of the industry. If the people who do this small work can be educated to workmanlike methods by the Association, and experience shows that most of them can be, those interested on a wider scale as manufacturers of cement and machinery will be materially benefited. The important engineers, architects and contractors can be reached most quickly and effectively through the trade press, but there is a numerous class, engaged on small work individually but whose collective work makes a large total, to which the conventions of the Association are the leading sources of information concerning progress in their calling. The past recognition of this fact has been a leading cause of the Association's growth.

The Westport Reinforced Concrete Power House.

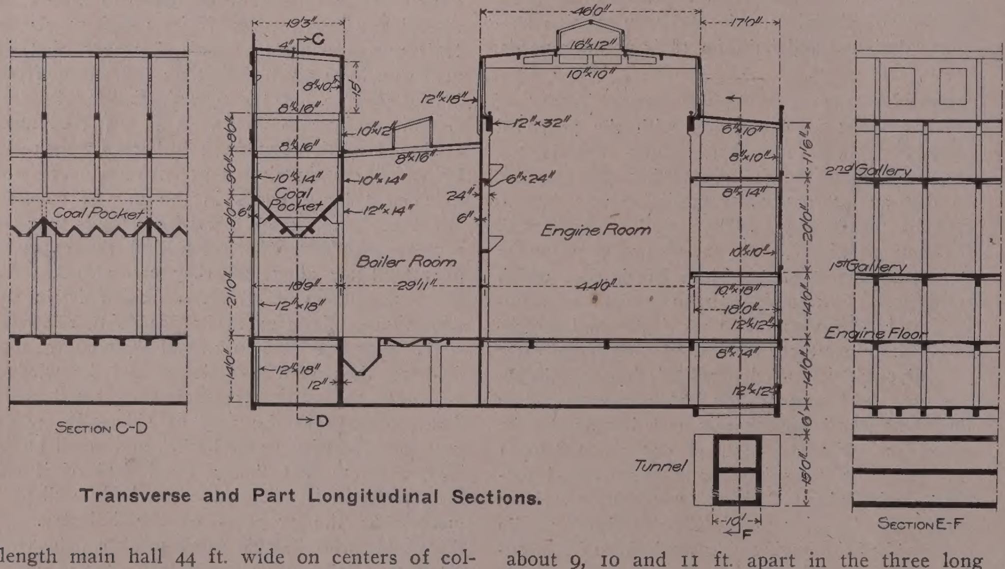
The Westport power house for the Consolidated Gas, Electric Light & Power Co., of Baltimore, Md., is built in the outskirts of that city on the Patapsco River, and is especially designed to provide for large future extensions. Provision is made for an ultimate sructure 466 ft. long and 255 ft. wide with a generating capacity of 70,000 electrical horse-power. This has been sub-divided into several symmetrical sections, the first of which marked 1 and indicated by full lines in the accompanying diagram is 110 ft. long, 255 ft. wide and about 79 ft. high over all and contains a 33,000-h.-p. steam and electric installation. It was built in 1905 and 1906 and the mechanical equipment was described in The Engineering Record of September 1, 1906. Subsequently part of the structure required to complete the first symmetrical half of the entire plant, marked 2 in the diagram, was constructed. The contract was also awarded and work started on the third of the large section on the south, and it is expected that eventually the remainder of this half and the whole of the other half will be built, completing the final installation as indicated by dotted lines. This will involve a total outlay of about $700,000 for buildings only, and its construction will be dependent on the requirements of the service. In general the details, arrangement and equipment are planned to conform with those described in our preceding article and in this issue.

The first section of the building consists of a boiler house and engine house, 255 ft. long and 48 ft. and 62 ft. wide respectively, which are separated by a common partition wall. They both have pile foundations supporting the bases of concrete piers 14 ft. below the surface of the ground, and are built entirely of reinforced concrete, cast in position to form a monolithic structure somewhat elaborate in details.

A cellar 14 ft. deep extends under the full area of the structure, and above it is the main floor 6 ft. above ground level in both boiler room and engine room. The engine room has a full-length main hall 44 ft. wide on centers of columns which is traversed by a 20-ton girder crane of 42 ft. span, about 47 ft. in the clear above the floor. The roof girders are 60 ft. clear of the floor and support a full-length center longitudinal monitor. On one side of the engine room there are two electrical galleries 18 ft. wide supported on transverse girders 11 ft. apart. The main aisle of the boiler house is about 30 ft. wide and about 40 ft. high to the roof girders and is separated by a longitudinal row of columns from the outer aisle nearly 19 ft. wide, above which there is a series of coal pockets with a capacity of 1,350 tons. The roof over the coal pockets is 24 ft. higher than the main roof of the boiler house, affording space above the pocket for a clam-shell bucket trolley which delivers coal either from the storage yard or from a boat to an electrically operated crusher trolley discharging into any one of the coal pockets. The coal pockets deliver through cut-off valves to traveling 1-ton hoppers by which the boilers are supplied. This system provides for filling the pockets at the rate of 60 tons per hour.



General Plan of Power House.

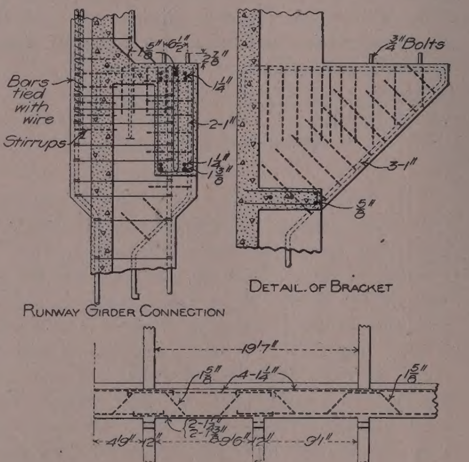


Transverse and Part Longitudinal Sections.

The roofs and floors are carried on columns with rectangular cross sections which are spaced about 9, 10 and 11 ft. apart in the three long exterior walls and in two intermediate longitudinal rows. The exterior walls, 6 in. thick, are made solid and are integral with the columns which project from their inner faces forming pilasters, 8, 10 and 12 in. wide. The outer wall of the engine house is reinforced with vertical and horizontal 3/8-in. rods from 10 to 12 in. apart. The rods are made in convenient lengths, with their ends overlapping about 12 in. and turned up about 1 in. at right angles to increase the bond in the concrete. At window openings the ends of the horizontal rods are bent back on themselves 180 deg., forming loops which engage vertical rods placed close to the edge of the opening. The outer wall of the boiler house has several ornamental projecting belt courses and cornice mouldings made integral with it between which it has a uniform thickness of 6 in. Horizontal rods are embedded in the mouldings at the corners and engage inclined stirrups of small wire which extend through the thickness of the wall as indicated in the detail of the cornice.

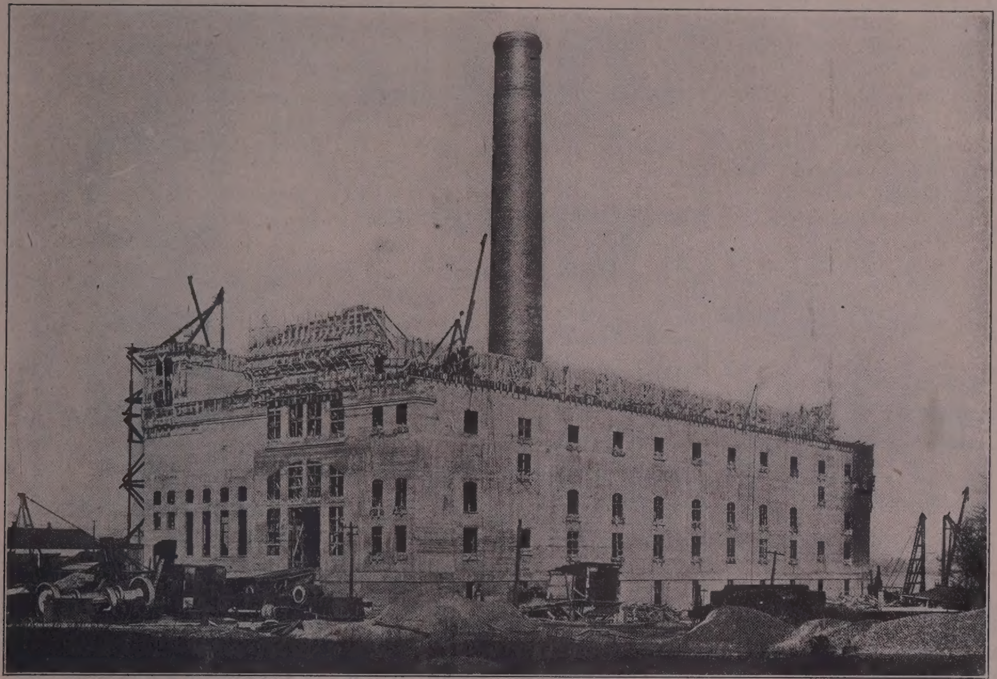
The wall between the engine house and boiler house has a uniform thickness of 6 in. and is solid up to the boiler house roof, and above it is pierced with windows in the clere-story of the engine house. The rectangular columns, 12 in. wide, are 9 to 11 ft. apart on centers, project 18 in. beyond the engine house face of the wall, and carry two tiers of brackets 3 ft. wide to support the heavy steam pipes. The main section of the column terminates at about the level of the side roof of the engine house where it supports the 12 x 32-in. crane runway girders. Above this point alternate ones are continued with a reduced cross section to carry the main roof girders, and are cantilevered 6 in. beyond the lower sections. The wall connecting the columns is stiffened by two lines of horizontal girders 6 in. thick which connect the columns at approximately equidistant points between the floor and roof. The lower ends of the pipe brackets are located at the girder levels and the brackets being made integral with both girders and columns and being heavily reinforced both with cantilever rods and shear stirrups are very strong and rigid.

The runway girders are continuous through or over all the columns and are connected to the clere-story wall by a horizontal web about 6 in. thick, which is integral with the top of the girder and with the wall. Each girder has two 1 3/8-in. straight bars in the lower part extending a little beyond both supporting columns with their ends bent 90 deg. to bond with the concrete. A single 1 5/8-in. lower flange bar is bent up 45 deg. at each end to the top part where it is bent horizontally and reaches across the adjacent column with hooked ends overlapping the corresponding bars in the next span so that these bars form a series of zig-zag lines running from end to end of the building. An additional line of four 1 1/4-in. horizontal straight bars runs through the top of the stringers from end to end.



Connections of Runway Girder and Pipe Bracket to Column.

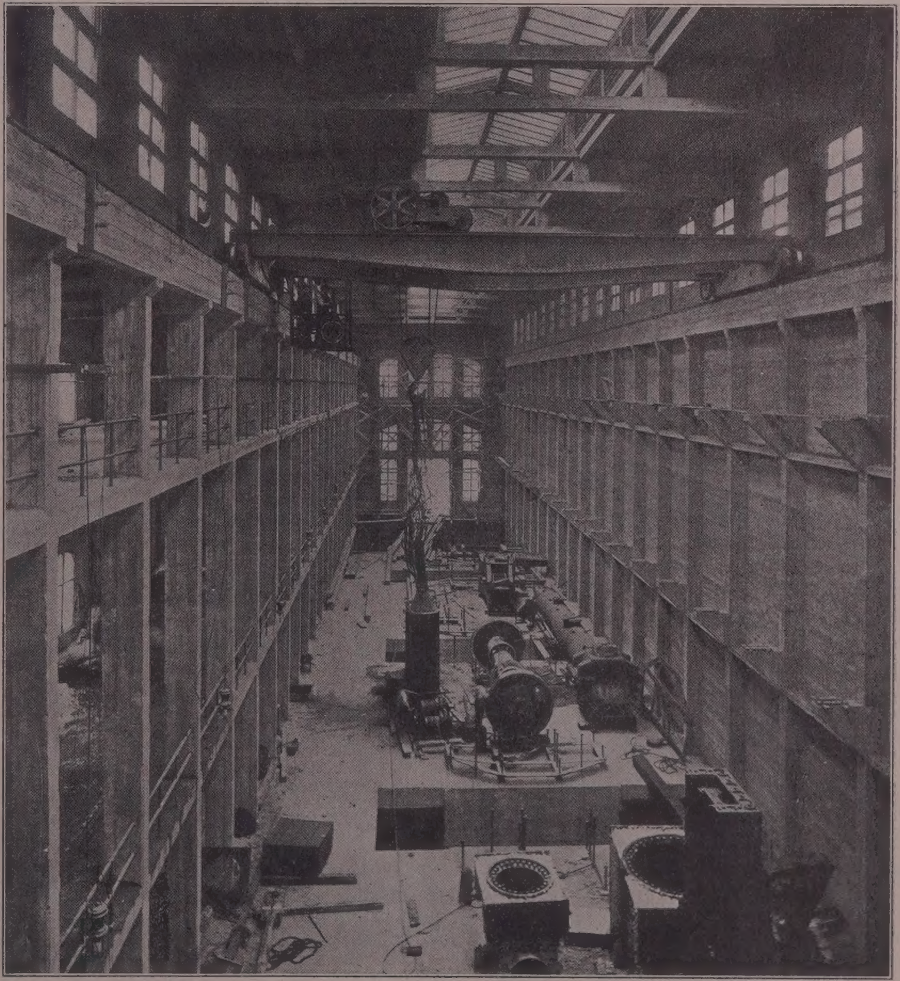
All columns have rectangular cross sections, part of which, in the case of the wall columns, is formed by the thickness of the wall which is made integral with it. All of them are reinforced with four to eight vertical bars tied together with pairs of horizontal stirrups from 8 to 24 in. apart made with double parts of small wire, or with rods up to 1/4 in. in diameter. To provide for future extensions on the south side the columns in that wall are made with special horizontal stirrups which project 2¼ in. beyond the exterior face of the wall, forming solid loops for eyes intended to provide a connection for future concreting.



First Section of Westport Power House nearing Completion.

As the building is one story and basement in height, the principal floors are those of the cellar which is throughout merely a 6-in. layer of concrete uniformly supported on the bottom of the excavation, and the first floor at about ground level which is supported on beams and girders. Besides these there are the two gallery floors proportioned for live loads of 600 and 200 lb. per square foot, which consist of reinforced concrete slabs carried by transverse girders from 9 to 11 ft. apart connecting the walls and intermediate columns. The floor slabs being concave on the under side are in reality very flat arches 4½ in. thick at the crown and 9 in. thick at the skewbacks and are reinforced with ½-in. longitudinal and transverse horizontal rods 8 in. apart on centers.

The main floor in the engine room encloses the massive engine foundations, which rise above its surface, and is proportioned for a live load of 1,000 lb. per square foot. It is made with arched slabs similar to those in the galleries which have a thickness of 3½ to 6 in., and spans averaging about 5 ft. in the clear. They are supported on transverse beams which are in general not concentric with the columns, except under the galleries, but are carried by massive longitudinal girders connected direct to and integral with the engine foundation piers and with the longitudinal row of gallery columns. All of the girders and floor beams are reinforced with straight horizontal rods in both the upper and lower edges and with bent rods rising from the lower to the upper edges of the beams in the ends. All of these rods have their ends for 1 or 2 in. bent at right angles to bond with the concrete in the wall or columns. The upper and lower rods are invariably connected with special upright and inverted stirrups calculated and located in accordance with the shear diagram, as indicated in the accompanying detail of a girder made without floor covering. The floor beams differ from the floor girders only in their dimensions and in the fact that their upper surfaces are in all cases integral with the floor slabs, a portion of which, 24 in. wide on each side of the beam is, as usual, computed as forming part of the moment of resistance of the beam. The combination of upright and inverted stirrups practically forms a series of complete rectangles with double vertical members which, however, are made in halves and separated longitudinally, their combined effect being, however, to completely enclose the main tension rods and the reinforcements of the slab, and form rectangles concentric with the faces of the beams and girders.



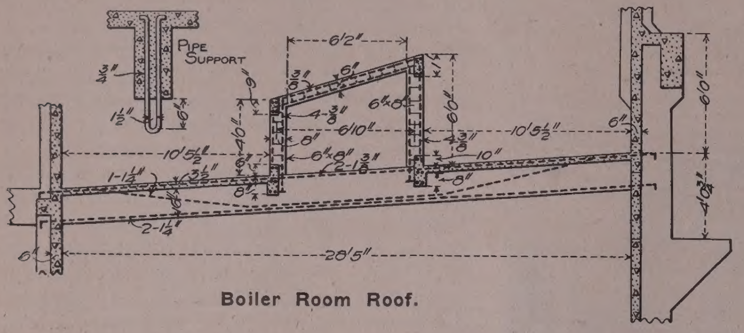
Interior of Engine House, Westport Power House, Baltimore.

All stirrups are made of ¼-in. rods and are of special type covered by the Kampmann patents. Each of them consists of a single rod bent to form a double U with both of the narrow loops of the upright stirrups projecting just above the upper surface of the upper main tension rods and engaging either the transverse reinforcement rods in the floor slabs or special short transverse rods, not here shown, in the upper part of the girder which carry their weight and secure them in position so that they serve as suspending stirrups to maintain the lower main tension bars at the required position clear of the lower surface of the beams or girders, thus preventing displacement and insuring the efficient disposition of the metal.

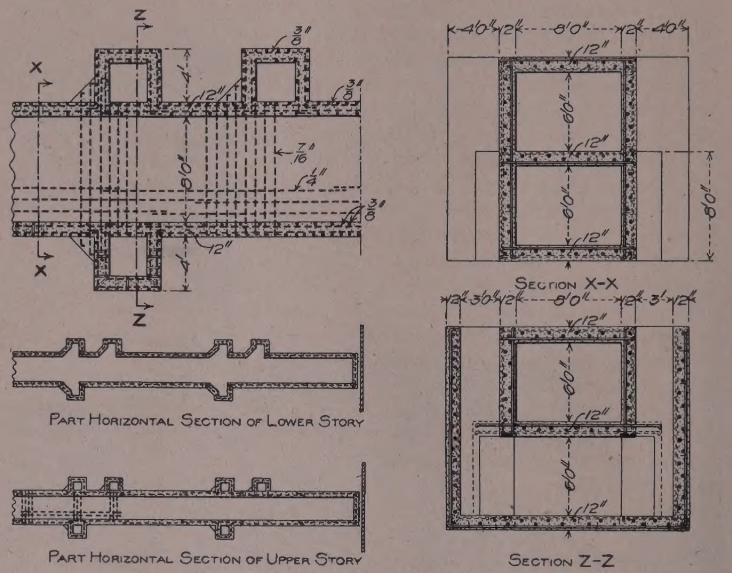
The maximum girders connect the engine foundation piers with a span of about 15 ft., and are 14 in. wide and 26 in. deep, including the thickness of the integral floor slab. They are reinforced with six 1⅝ and two 1⅜-in. rods in the lower part and three 1⅝-in. rods in the upper part and have stirrups placed from 3 to 10 in. apart.

In front of the boilers the space under the main floor forms an air duct with numerous rectangular openings all 22 in. deep and most of them 22 in. wide through the upper part of the inside wall. The floor above the duct is proportioned for a live load of 1,000-lb. per square foot and is made with flat arches of about 5 ft. clear span similar to those of the other floors.

Underneath the boilers there is a special floor, made as indicated in the general section, with two longitudinal rows of shallow hoppers to receive the soot from the combustion chambers and a third longitudinal row of larger and deeper hoppers to receive the ashes. All of the hoppers have bottom gates discharging their contents into cars on service tracks on the cellar floor. The floor under the combustion chambers has a uniform thickness of 5 in., and between and around the soot hoppers forms a continuous horizontal surface reinforced with ⅜-in. longitudinal and transverse bars 8 in. apart. The hoppers are square with inside widths of 4 ft. 4 in. at the top and 16 in. at the bottom and a depth of 26½ in. over all. Their sloping sides are reinforced, similar to the floor above, with ⅜-in. horizontal rods 8 in. apart bent to form complete rectangles enclosing all sides of the hopper. The floor is divided by transverse and longitudinal girders into panels about 18 ft. wide and from 20 to 22 ft. long. The 14½x8-ft. ash hoppers 8 ft. deep have vertical walls 4 ft. 2½ in. high and inclined bottoms similar to those of the soot hoppers except that they are made with two gates each, and that their inclination is much greater than for the soot hoppers. An enlargement at the lower edge of the vertical wall virtually forms a horizontal girder which is connected at the ends to the main girder above by ½-in. U-shaped hangers as shown in the detail.



Boiler Room Roof.



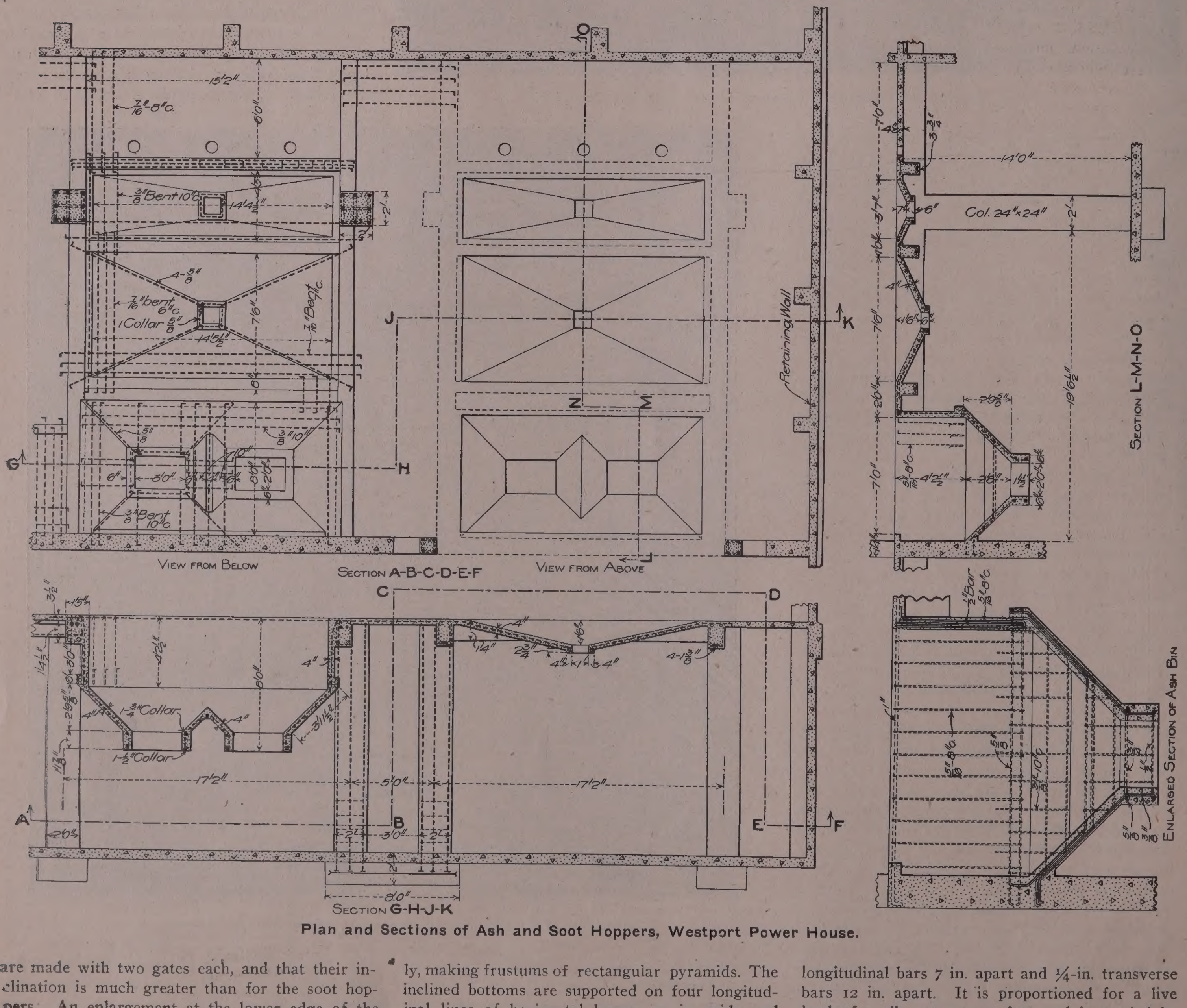
Section X-X

Part Horizontal Section of Lower Story

Part Horizontal Section of Upper Story

Section Z-Z

Tunnel for Condensation Water.



View from Below

Section A-B-C-D-E-F

View from Above

Section L-M-N-O

Section G-H-J-K

Enlarged Section of Ash Bin

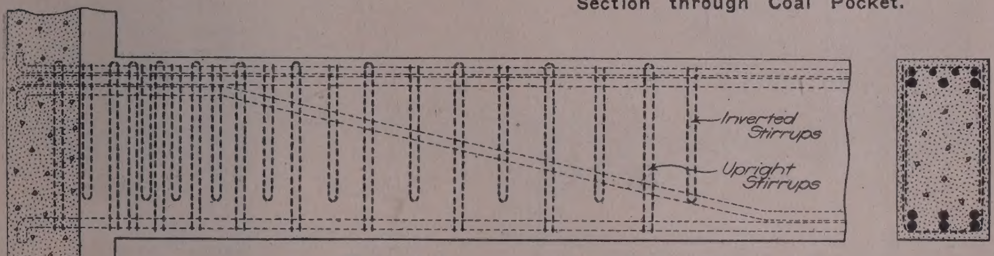
Plan and Sections of Ash and Soot Hoppers, Westport Power House.

The coal pockets have a total storage capacity of 1.350 tons and extend the full length of the building with a uniform inside width of 18 ft. 3 in., and an effective depth of 15 ft. to the lowest part of the hopper bottom. The vertical side walls are 6 in. thick and are integral with the 6-in. bottoms which are inclined 45 deg. with the horizontal, both transversely and longitudinally, making frustums of rectangular pyramids. The inclined bottoms are supported on four longitudinal lines of horizontal beams, 10 in. wide and 22 in. deep, normal to them. These beams are seated in solid concrete saddles or bearings built up from the upper surfaces of massive transverse girders 3 ft. deep and 12 in. thick, which transfer the weights of the coal bins to the columns.

The roof over the engine house is pitched about 9 in. in 16 ft., and is reinforced with 5/16-in. longitudinal bars 7 in. apart and ¼-in. transverse bars 12 in. apart. It is proportioned for a live load of 70 lb. per square foot and is carried by transverse girders of 44 ft. clear span which are 10 in. thick and 4 ft. deep at the centers. These girders are of special construction with rectangular top flanges 16 in. wide and 12 in. deep and bottom flanges 10 in. wide and 10 in. deep connected by a vertical web 10 in. thick which is solid for 8 ft. from each end of the girders and in the center has three open panels about 6 ft. long and 26 in. deep separated by short sections of the web cast integral with the top and bottom flanges and resembling vertical posts of an ordinary truss. The panels are not provided with diagonal members and the construction is therefore not that of a true truss, the open panels serving merely to reduce the amount of concrete in the girder and to diminish the dead load and the obstruction to light and increase the circulation of air.

The inclined top flange of the girder is a regular compression member reinforced with three 1¼-in. and two 1-in. full-length bars. The lower flange is reinforced with two 1¼-in. and four 1⅜-in. bars and each vertical post is reinforced with four ¾-in. full-length bars with their upper and lower ends bent at right angles to bond with the concrete in the top and bottom flanges.

The solid web is reinforced with vertical stirrups spaced in accordance with the shear diagram and the flange and vertical post reinforcement rods are hooped with rectangular transverse bent rods like those used in ordinary column construction. The girders support 6x10-in. longitudinal purlins spaced about 7 ft. apart which, like the top flanges of the girders are cast integral with the 4-in. roof slab. Each main girder is proportioned for a total load of 110,000 lb., and has maximum moment and end shear of 600,000 ft. lb. and 55,000 lb. respectively.



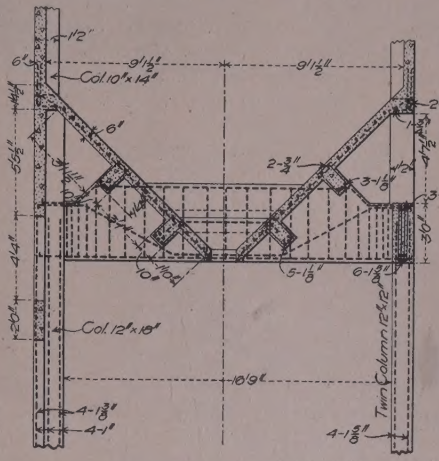
Typical Arrangement of Special Stirrups.

Each girder supports one bent of the monitor framework which has two vertical columns 13 ft. apart on centers and 52 in. high. The tops of the vertical columns are connected to the inclined rafters with solid-web knee-braces reinforced by diagonal rods, thus making a continuous monolithic structure for each bent. The bents are connected longitudinally with 10x4-in. horizontal eaves purlins and by an 8x12-in. ridge purlin, thus forming a skeleton framework, the spaces between the members of which are filled with louvres and skylight glazing.

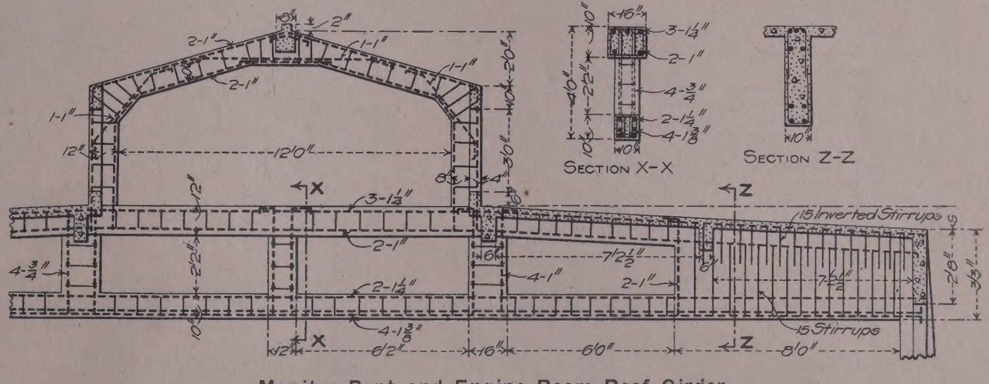
The water required to supply the condensers and boilers is received and discharged through a rectangular 2-story tunnel of reinforced concrete which is about 300 ft. in length and was built in open trench and in a coffer-dam under the engine house gallery with the lower floor 35 ft. below the main floor of the engine house. The lower story of the tunnel is used for an intake and the upper story for a discharge, each having a normal cross section 6 ft. high and 8 ft. wide in the clear. Extensions, sloped toward the river to reduce friction, are made from both sides of the lower tunnel to receive the suction pipes. The vertical and horizontal walls are all continuous concrete slabs 12 in. thick reinforced with ⅜-in. longitudinal and transverse bars near the inner and outer surfaces.

The principal quantities involved in the construction were about 300,000 ft. of timber, board measure, for falsework and centering, 6,000 cu. yd. of concrete and 750,000 lb. of reinforcement steel. The concrete was made entirely with Alpha Portland cement mixed in two one-third yard Ransome machines. Proportions of 1:3:6 were used for the foundations and engine piers and 1:2½:5 for the floor slabs and girders.

Messrs. Simonson & Dietsch are the architects of the building, and Mr. P. O. Keiholtz was the consulting engineer for the Consolidated Gas, Electric Light & Power Co. The general contractor was the Baltimore Ferro-Concrete Co., Mr. H. J. West, president, Mr. Henri Kampmann, C. E., treasurer, Mr. H. Massart, designer, and Mr. C. Signot, superintendent in charge of construction.



Section through Coal Pocket.



Monitor Bent and Engine Room Roof Girder.

Fish Culture in Sewage Effluent is successfully practiced at the sewage disposal farm at Blankenburg, Germany, according to a report by City Surveyor C. F. Wike, of Sheffield, England. The sewage effluent contains large quantities of worms, larvæ, and other forms of life which certain fish readily consume. A pond of about 15 to 20 acres had been constructed, through which the effluent was passed in order to rid itself of sewage fungus, and into this pond fish were introduced, careful investigation having first been made as to which species were likely to give the best results. The growth of the fish is very rapid, and there is no difficulty in disposing of them as food. At Sheffield, Mr. Wike states, golden carp have been kept in the effluent of the bacteria beds for long periods to demonstrate its satisfactory quality. Some of these carp reached an age of over six years.

The Significance of Bacterial Counts.

The difference between the significance of a chemical analysis of water or sewage and a bacterial analysis is marked. The chemist makes determinations of six or more different factors, and knowing the influence which pollution may exert on each factor and on their relation to one another, he is able to make an interpretation of the significance of the complete analysis with a considerable degree of accuracy. On the other hand, the bacteriologist usually determines the number of bacteria collectively and perhaps makes a qualitative test for one type, taking much more time to do this than the chemist requires for his work. In order that the bacterial determinations may reach the same plane of usefulness as the chemical analysis, the procedures must be so modified that they shall yield more complete information than now and within a shorter time. This subject has received serious consideration for many years at the Lawrence Experiment Station, and Mr. Stephen De M. Gage, its biologist, has reached certain conclusions regarding it which he states as follows in the 1906 report of the Massachusetts Board of Health, just published.

Modern methods of bacterial examination of water, consisting usually of determinations of the numbers of bacteria by means of plates incubated at room temperature, and of tests for the presence or absence of one or two specific types, occasionally lead to an erroneous interpretation of the quality of a water, owing to the fact that they do not yield adequate data by which abnormal and inaccurate results may be separated from those which are truly indicative of purity or pollution. Furthermore, as several days must elapse before the bacterial tests can be completed, the results when obtained may have passed their usefulness. If, however, we can so modify our procedure that the varied character of the bacteria in waters of different classes may be quickly and accurately recognized, the value of bacterial water analysis will be enormously increased. Much of this information may be obtained by the use of selective media, selective temperatures or by a proper combination of the two.

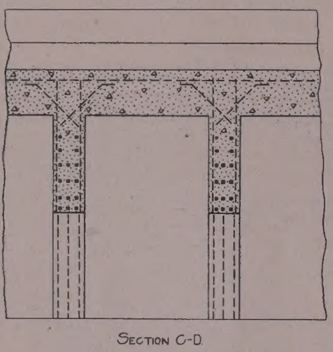
By the use of litmus-lactose-agar in place of agar or gelatin we obtain similar counts of total bacteria, and in addition are able to separate those bacteria into two groups, which do and do not produce acid fermentation of lactose, and the numbers of the two classes of bacteria so obtained indicate more completely the character of the water than would the numbers of either class alone. By incubating our plates at temperatures of 30° or 40° C. we are able to obtain counts in twelve to eighteen hours, which counts, while smaller than those on plates incubated for a longer period at a lower temperature, appear to be fully as significant. If we increase our number of determinations by incubating duplicate plates at two or more temperatures, the various results and the ratios between them furnish a check upon one another, in addition to increasing the available data upon which to base an interpretation.

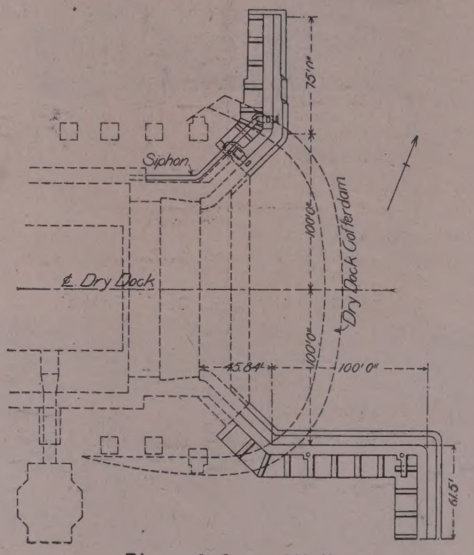
The distinction between polluted waters and waters of good quality is more sharply marked by counts at 30° C. than is the case with counts at 20° C. Determinations at this temperature appear to be especially applicable to the control of water filters, since the relative quality of the raw and filtered waters and the expression of the removal of bacteria by those filters are practi- C., and, in addition, they become available within a few hours after the sample is collected.

The numbers of bacteria determined at 40° C. are of great value, since in this class of bacteria must be included the bacillus of typhoid fever and other water-borne diseases. The significance of the acid-producing bacteria determined at this temperature, that is to say, bacteria of the colon type, is well known. Considerable numbers of bacteria of the colon type may occur in waters which are supposedly of good quality, judging from its total bacterial content, while on other occasions positive tests for B. coli may be caused by isolated organisms of that type. In such cases no distinction could be made between the relatively good and the suspicious samples, either by the numbers of bacteria or by the qualitative colon tests, but the necessary information would be obtained by counts at 40° C. Determinations of B. coli by the plate method in the effluents of water filters agree with determinations by the fermentation test in about half of the samples, the isolation of B. coli being prevented quite frequently in this class of samples by the presence of the sewage streptococcus type, which would be included in the colon type under the plate method.

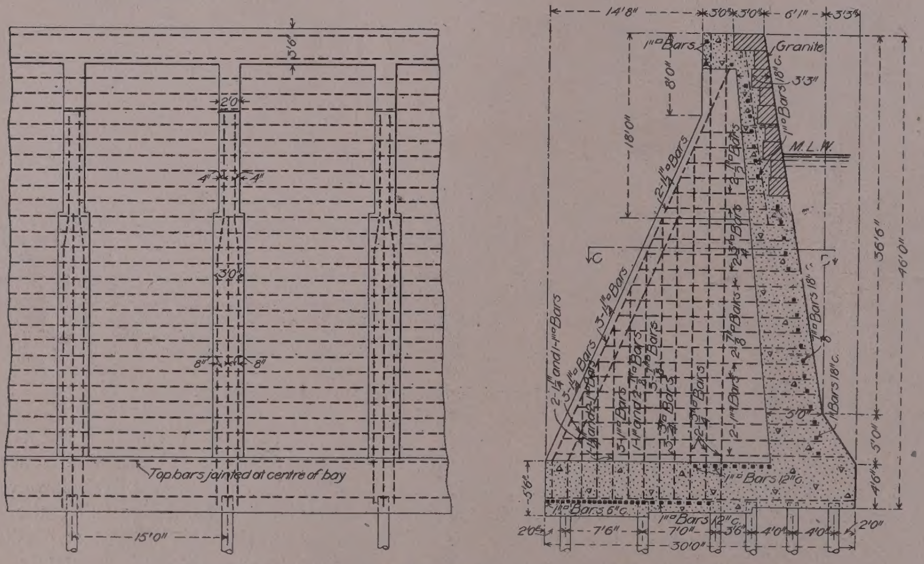
The results of determinations of the bacteria developing at 50° C. are too few in number to enable any definite conclusions to be drawn as to their value. Bacteria of this type appear to be quite common in sewages and in the effluents from contact and trickling filters, while they are present only in small numbers in the effluents from sand filters and water filters, and are entirely absent from well and pond waters of good quality.

Determinations of bacteria and B. coli on the Merrimack River water extending over a period of some nine years enable us to study the bacteria to B. coli ratios and to ascertain with some accuracy the cause of fluctuations. In general, it may be stated that the proportion of B. coli in the river water is greater when the water is warm than when it is cold, and that the effect of heavy rains or melting snow, causing floods in the river, is to produce a diminution both in the numbers and in the proportion of B. coli. The effect of the amount of oxygen in the water is also noticeable, both bacteria and B. coli being at a maximum when the water contained between 0.50 and 0.75 parts of dissolved oxygen, decreasing as the oxygen value varied above or below that amount, the B. coli decreasing much more rapidly in either case than did the total number of bacteria.


Section C-D.



Plan of Quay Walls.



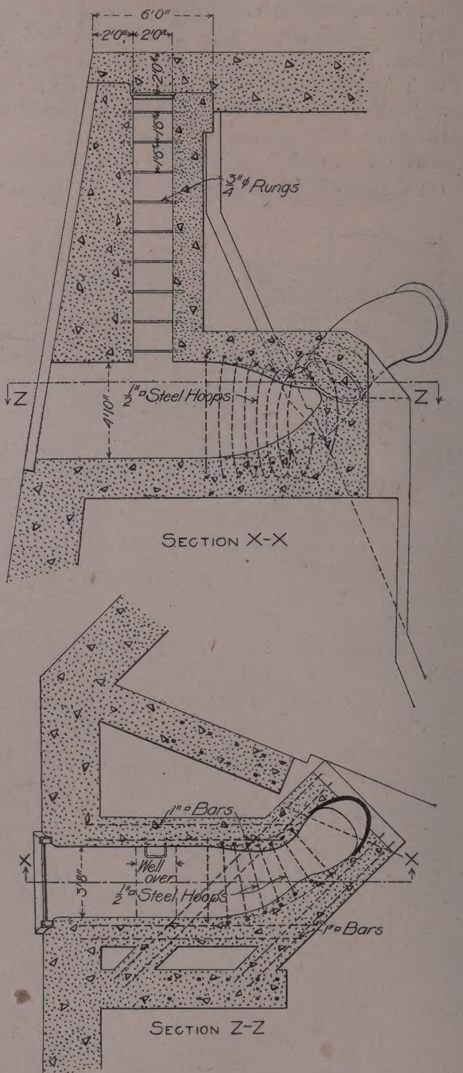
Reinforcement of Maximum Section of Quay Walls.

A Water Heater for utilization of the waste heat in the exhaust of a gas engine, has been applied to a 50-h.-p. gasoline engine. The latter is a two-cylinder vertical engine with 2½-in. exhaust connections from either cylinder and in each of these were inserted short lengths of 6-in. pipe containing series of cast-iron heater sections, fitting within the pipe and containing 35 sq. ft. of surface each. The water in these heats rapidly and circulates naturally through an 80-gal. tank which is boiled every two hours.

Quay Walls for the New Dry Dock at the Charleston Navy Yard.

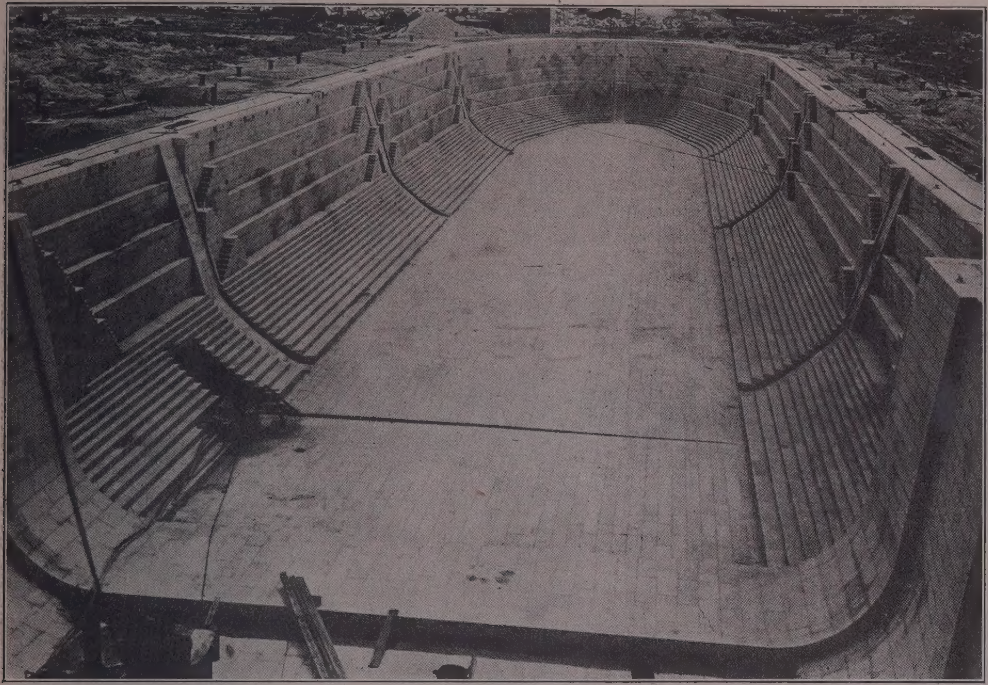
The quay walls of Dry Dock No. 1 at the Charleston, S. C., Navy Yard, which are now nearing completion, are exceptionally massive walls, built of concrete, heavily reinforced with steel bars and with buttresses on 15-ft. centers. On account of the heavy proportions, the extensive reinforcement, and the foundation conditions, both the design and construction present interesting features.

The dry dock to which the walls form the approach has been described in The Engineering Record in two different articles, in the issues of March 4, 1905, and March 3, 1906. It is constructed of solid concrete, lined throughout with Georgia granite, has a length of 618 ft. over all, an inside width at the top of 134 ft., and, in the body of the dock, a depth of 42 ft. 3 in. The site is in a marsh over 800 ft. from the bank of the Cooper River, to which the dock will be connected by a dredged channel. The underlying soil consisted of marl, a hard, impervious clay, overlaid with about 30 ft. of soft marsh mud. The dock was built upon the marl as a foundation without piles. As shown in an accompanying illustration the dock is now completed and will be ready for service upon the completion of the quay walls and the piers forming the channel to deep water in the river.



Detail of Discharge Conduit.

The quay walls, which are to be particularly described in this article, form the approaches on either side of the dock, and from their ends piers 656 ft. long will be constructed to the river. The north wall is 100 ft. long and the south wall 200 ft. The design of both walls, except for the foundations, is identical and consists of a concrete wall supported by buttresses, and faced with granite from the top down to a point below low water, so that above the water they correspond in appearance to the face walls of the dry dock. The walls are 46 ft. high above the bottom of the base, which is approximately 36 ft. below mean low water. The proportions of the wall can be judged from the size of the base, which has a thickness of 5 ft. and a width of 30 ft. The top of the coping has a width of about 6 ft. The reinforcement consists of square bars of steel, and the concrete of a 1:2½:5 mixture, the aggregate being granite crushed to pass a 2-in. ring. Old Dominion brand of Portland cement was used.


Completed Dry Dock at Charleston, S. C., Navy Yard.

The north wall rests upon piles, 34 ft. long, driven to a final penetration of 1½ in. with a 6-ft. fall of a 5,000-lb. hammer. These piles are placed in 2 rows beneath the main part of the wall, their distance apart in each row being a minimum of 3 ft. 9 in. at the normal high section and 5 ft. at the lower section of the wall. Two additional piles are driven on the center line of each buttress.

On the south side, on account of the heavy pressures developed against the sheeting of the cofferdam, it was feared that the shaking of the derricks during pile driving might destroy the stability of the ground and thus cause the failure of the cofferdam. For this reason it was decided to eliminate the piles on the south side and to substitute a curtain wall at the toe of the foundation slab, one of the factors in this decision being the fact that a test of the sub-grade, when the excavation was completed, showed a bearing power of 15 tons per square foot. The toe wall is 4 ft. thick, 4½ ft. deep beneath the bottom of the base and is reinforced and connected to the base slab by 40-lb. old rails, 9 ft. long, spaced 2 ft. on centers.

The face of the wall between the buttresses is very heavy and runs from a thickness of 5 ft. 6 in. at the bottom to about 3 ft. 3 in. at the top. It is reinforced with 1-in. square bars at the bottom and with ¾-in. bars at the top, these bars being laid horizontally on 18-in. centers, 12 in. back from the front surface of the wall.

The reinforcement of the footings is placed in the bottom, and also near the top, immediately back of the wall. The latter reinforcement consists of horizontal 1-in. bars on 12-in. centers, running longitudinally, the first bar being immediately under the back surface of the wall. In the bottom of the footings both transverse and longitudinal steel is used. The transverse steel consists of 1-in. bars on 3-in. centers, and the longitudinal steel of 1-in. bars spaced 6 in. on centers in the portion of the footing farthest away from the face of the wall and on 12-in. centers through the central portion.

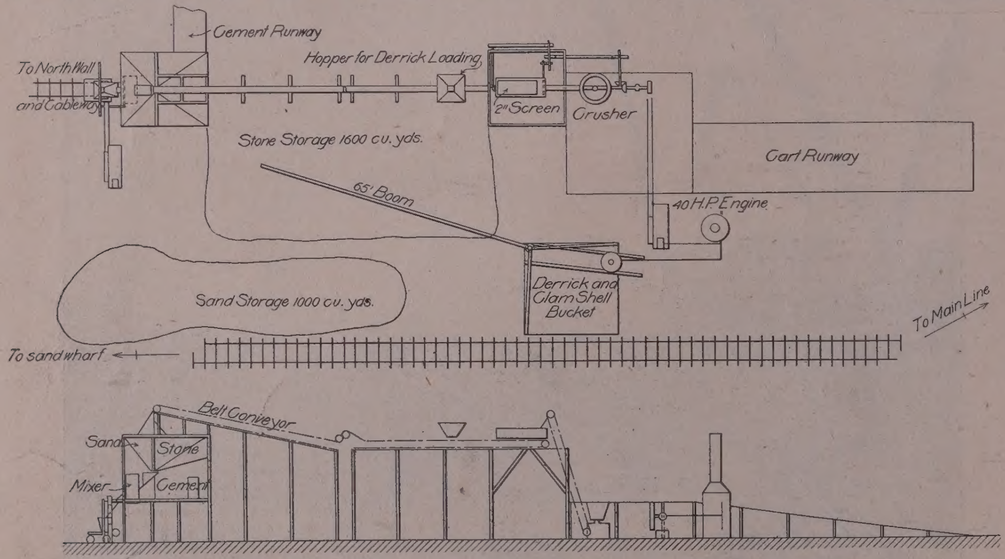
Heavy Bracing of Cofferdam for South Quay Walls.

The most complicated reinforcement is that in the buttresses and consists of horizontal and vertical rods and of diagonals having the same slope as the back of the buttresses. The vertical rods are on 18-in. centers and vary in size from ¾-in. to 1¼ in., two or three of them used together according to the stresses to be carried. Like the vertical rods the horizontal reinforcement of the buttresses is placed on 18-in. centers, and consists, towards the bottom, of pairs of 1-in. bars running out into the face of the wall, of ⅞-in. bars in the central portion, and of pairs of ¾-in. bars at the top. In the plane of each buttress, immediately back of the granite facing, which is placed upon the front of the wall for a distance of 15 ft. 9 in. down from the top, are one-inch bars having the same slope as the front batter of the walls. The wall is tied to the buttresses not only by the straight horizontal bars mentioned, but also by special ⅞-in. bars, spaced vertically on 18-in. centers, and laid in the wall running into the buttresses at about an angle of 45 deg.

The diagonal bars in the buttresses consist of six 1¼-in. bars toward the bottom and of two 1¼-in. bars at the top. For a distance of 18 ft. down from the top of the wall, the buttresses have a width of 2 ft. and for the remainder of the distance to the base of 3 ft., and through the latter portion the six reinforcing rods are used. They are laid in two rows of three each, one row being 6 in. from the upper surface of the buttress and the other 24 in. Two 1-in. bars are used to reinforce the bottom of that part of the coping which overhangs between the buttresses. The total amount of steel reinforcement is about 100 tons.

The north quay wall has an additional complication in two 36-in. siphon pipes used for emptying and filling the docks. The intake and the discharge are located in separate places and passages are formed in the solid concrete for a short distance before connection is made to the cast-iron pipe. This results in some interesting reinforcement, vertical stirrups of half-inch bars being looped up and around the intake channel, while steel hoops of ½-in. bars are used for the reinforcement around the discharge channel. Wells are provided from the top of the wall down into the intake and discharge passages, and the exclusion of trash and floating material is prevented by means of screens. The pipes are carried on a horizontal concrete shelf back of the buttresses.

On account of the nature of the ground the construction proved a difficult undertaking. The excavation was started in black marsh mud. At a depth of 16 ft. a boiling white sand was encountered which continued for a depth of 8 ft., then 4 ft. of blue clay, followed by 8 ft. of very hard marl. The original cofferdam, which was constructed when the dry dock was built, was left in place and where the quay walls came within it, for a distance of about 35 ft., the river side of the quay wall cofferdams was left open for this distance. The cofferdams were 34 ft. wide, giving a clearance on each side, at the bottom, of 2 ft. outside the base of the walls. Tongue and grooved sheeting 48 ft. long was used and much difficulty was experienced in driving it on account of the quick sand and marl, most of the piles requiring from 200 to 250 blows of a 3,000-lb. hammer. As soon as the excavation was started it was necessary to cut through the dry dock cofferdam, though leaving the portion in front of the dry dock intact. This was safely accomplished by a trussed brace, consisting of three very large long-leaf pine trees, 50 to 60 ft. long, butted against the dry dock apron and resting against wales at the point where the cofferdam was cut. These trussed braces were relieved in part by triangular braces of 12 x 12-in. timbers running back against the dry dock wall.


Cement Runway
Hopper for Derrick Loading
To North Wall and Cableway
2" Screen
Crusher
Stone Storage 1600 cu. yds.
Cart Runway
65' Boom
40 H.P. Engine
Derrick and Clam Shell Bucket
Sand Storage 1000 cu. yds.
To Main Line
To sand wharf
Belt Conveyor
Sand
Stone
Mixer
Cement

Plan and Elevation of Concrete Plant for Constructing Quay Walls.

As the excavation proceeded 12 x 12-in. wales were put in against the sheeting and held by 12 x 12-in. braces. For the north wall this system was put in with 10-ft. horizontal centers and 7-ft. vertical centers. When the excavation was carried down close to the sub-grade it was found that many of the sheet piles were distorted and broken and in consequence the timbering in the boiling sand was difficult. The pressures ran very high and it was necessary to use 14 x 14-ft. timbers through the sand bed.

On the south side the earth pressures were found to be even heavier than on the north side, and 14 x 14-in. timber was freely used. It was found necessary to space the wales and the braces on 3-ft. centers vertically.

The concrete in the north wall was carried up in three sections longitudinally, that in the south wall in 4 sections. Five days elapsed between the depositing of concrete and the cutting out of the next tier of braces and rebracing the cofferdam against the concrete last deposited.

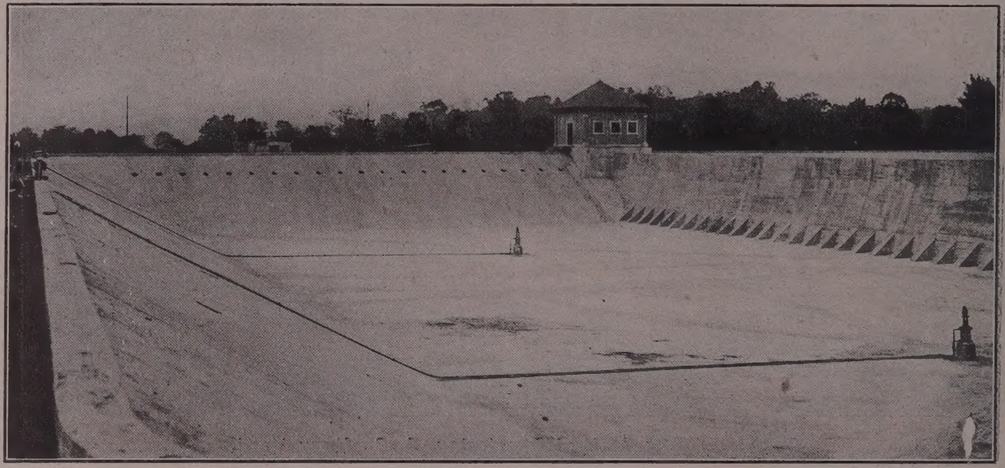
The sand for the concrete is delivered at a wharf on the bank of the river in barges, and unloaded from the latter to cars, running on a track on the wharf, by means of electrically-operated hoists. The cars are then hauled to the concrete mixing plant, which, as will be seen from the accompanying illustration, is an interesting lay-out. The stone comes to the plant in carts which are hauled up a runway and dumped into a No. 4 Austin gyratory crusher. The crushed stone falls into a hopper from which a bucket elevator carries it to a 2-in. screen mounted on a platform close to the crusher. From the screen the stone reaches a Robbins belt conveyor, which runs half way across a trestle, and discharges at its end onto a second belt leading to two storage bins. The space under the trestle is used for stone storage and has a capacity of 1,600 cu. yd., the belt being made to discharge at any desired point along the trestle. The sand is dumped alongside the railroad track.

A supply derrick with a 65-ft. boom covers the sand and stone storage piles and by means of a clam-shell bucket deposits sand and stone in a hopper mounted on the trestle above the belt conveyor.

One of the storage bins with a capacity of 17 cu. yd. is used for sand, and the other of 35 cu. yd. for stone. Beneath them is mounted a No. 4 Ransome concrete mixer, and on the same level as the mixer is a 200-bbl. cement storage shed. Cement is wheeled to the shed up a small runway from the railroad cars.

The concrete is dumped from the mixer into bottom-dump buckets on cars running on narrow gauge tracks. These were extended out over the cofferdam of the north quay fall, where derricks picked up the buckets and lowered them to the point where the concrete was needed. The mixing plant was located on the north side of the dock, and the concrete was carried over to the south wall by a Lidgerwood cableway of 400 ft. span. The buckets were handled from the cableway on narrow gauge tracks and by derricks, as in the case of the north wall.

The plant has a capacity of 40 cu. yd. per hour, but on account of the necessity of carrying small loads, due to the small spaces in which the concrete was placed and the difficulty of the reinforcement, the usual operating rate was about 16 cu. yd. per hour. Four men are required at the mixer, in addition to an engine tender and two men to push cars and to hook on. The crusher requires two tenders and an oiler, and the remainder of the crew consists of a shoveller on the belt conveyor, an engineman and a fireman.



The Interior of Coagulating Basin Number Two, Cincinnati.

The foundation piles were driven by a special pile driver hammer, consisting of a hollow cast-iron cylinder which fits over the top of the pile. The cylinder is 7 ft. 8 in. long over all, 2 ft. in outside diameter, and is hollow for 6 ft. 10 in. It is swung on a rope from a derrick boom, and does not require leads of any description, since in raising it for a blow it is lifted but 6 ft., leaving 10 in. still projecting below the top of the pile. For the work described it possessed two distinct advantages. Since it requires no leads, the difficulty usually found with ordinary pile drivers in cofferdam work, due to moving leads where there is much bracing, was done away with. The second advantage was the fact that the derrick could be located on solid ground, thus avoiding the danger due to vibration consequent upon mounting an ordinary derrick in a cofferdam. This was an important item in such unstable ground developing heavy pressures. The hammer weighs 5,000 lb. It is used in and near Charleston for re-piling wharves, and allows of driving interior piles by making a small aperture for the line in the roof. The device is patented by Mr. H. W. Crouch, of Charleston, S. C.

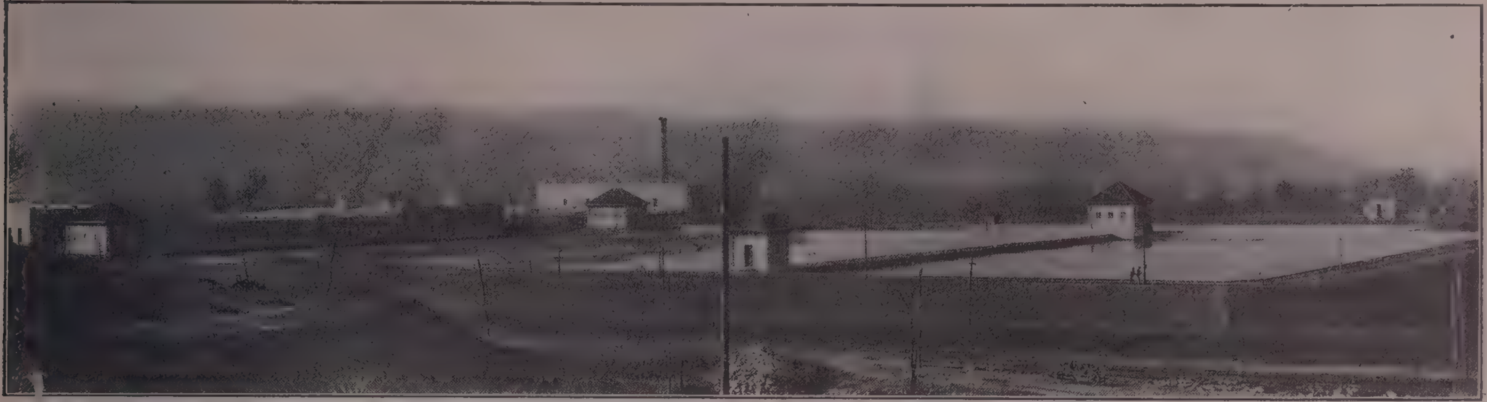
The work was started on April 28, 1907, and will be completed in January, 1908.

The work is being done by the New York Continental Jewell Filtration Co., 15 Broad St., New York, Mr. E. G. Williams, chief engineer. Mr. H. M. Dougherty is resident engineer, and Civil Engineer W. H. Allen, U. S. N., has supervision for the Navy Department.

The Second Track Construction on the Canadian Pacific Ry. has been completed for about 300 miles between Fort William, Western Ontario, and Winnipeg, Manitoba, and it is thought the double-tracking will be completed the entire distance late in 1908.

The Cincinnati Water Purification Plant.

The new water purification plant of the City of Cincinnati was put into full operation Nov. 1, after a short test run, and since that date the entire water supply of the city, 40,000,000 to 50,000,000 gal. daily, has passed through the plant. The filtration has been satisfactory and uninterrupted and the plant is showing good efficiency with economy of labor, chemicals and wash water.



General View of the Water Purification Works at Cincinnati, Ohio.

An illustrated description of these works was published in The Engineering Record of April 6, 1907. In the above view the buildings in the background at the left are, beginning at the left, the head house, the long, low filter house, and the chemical house. In theforeground are the two large coagulation basins, while between them and the filter house is a third one which is barely shown on account of its comparatively small width. Behind the coagulating basins in the background is the clear-water reservoir.

Chute to Receive Lime.

Sulphate of Iron Room.

The plant comprises an intake pier in the Ohio River and a tunnel leading under the river to a pumping station with four 30,000,000-gal. pumps; two lined settling reservoirs, formed by dams across the lower ends of ravines, with a combined capacity of about 345,000,000 gal.; three coagulating basins, with a combined capacity of 22,000,000 gal.; twenty-eight rapid filters with head-house and chemical house; and a 19,000,000-gal. clear water reservoir. These structures were described in considerable detail in The Engineering Record of April 6, 1907. An accompanying illustration gives a general view of the entire plant, showing the three coagulating basins, with the clear water reservoir behind and below them and the head-house, filter house and chemical house along one side; the three buildings are placed in the order mentioned with the last named most distant, and form together a continuous structure.

The raw water is pumped from the river to the settling basins, which are about 145 ft. above low water in the river. From the settling basins the settled water passes to the head-house, where there are controllers for reducing the pressure due to the elevation of the settling basins to that of the coagulating basins, a maximum difference of about 35 ft. Leaving the controller chambers the flow is through two channels in the head-house where sulphate of iron solution from the chemical house is introduced into the water by means of grids of perforated pipes. Passing to a valve chamber, shown on the extreme left hand side of the general view, the water there receives a charge of caustic lime in the form of lime water, which enters the chamber at the bottom through a 24-in. pipe from the chemical house. The operation of the coagulating basins as regards direction of flow through them and period of sedimentation can be varied readily.

The large volumes of solutions required are prepared in the chemical house. The volume of lime water needed would, under maximum conditions, amount to about 5 per cent. of the total flow through the plant. The volume of the iron solution is, of course, much less. Both solutions flow to their points of application by gravity. The iron solution is prepared in five cylindrical tanks, each about 5 ft. in diameter and 12 ft. deep. Circulation of the liquid is effected by a small propeller pump in each tank actuated by an electric motor on the floor above. Caustic lime will be slacked in six steel tanks, 6 1/3 ft. in diameter and about 3 ft. deep, three of which will be in use at one time with the others in reserve. The slacking water will be at about 120° Fahr. and slacking will be promoted by mechanically operated rake stirrers. The solid lime is introduced through an opening in the floor above each tank. Over each opening is a sheet-iron hood provided with a vent pipe extending through the roof. When the door of the hood is opened an exhaust fan is automatically started; this creates a draft which draws air from the top of the hood and prevents steam and lime from escaping through the hood door. Two accompanying views of parts of the second floor of the chemical house show a lime chute with its hood, part of the coagulant stirring apparatus and a storage pile of 100-lb. bags of iron sulphate.

The coagulating basins are formed partly in excavation and partly in embankment. Basins 1 and 2 have a capacity of about 10,000,000 gal. each and together form a basin about 400 ft. square at the top of the slope; basin 3, nearest the filter house, has a capacity of 2,000,000 gal. and is 400 x 80 ft. at the top. The sludge deposited in the basins will be removed periodically through cast-iron pipe drains laid under the bottom. There are two drainage outlets in each basin, each outlet being provided with a hydraulically operated plug valve. Hose couplings are provided on a pressure pipe around the top of the basins for use in flushing out. The inside of basin 2 is shown in an accompanying illustration in which the division wall between basins 1 and 2 and the two plug valves in basin 2 may be seen.

The filters and the galleries between them are covered by a house about 500 ft. long and 137 ft. wide. Each filter is 32 x 50 ft. in plan and 10 ft. deep. The filters themselves and the method of operating them were fully described in the issue of this journal before mentioned.

The Extremely Low Temperature of —111° Fahr. has been recorded by apparatus sent up in a miniature balloon to an altitude of 46,680 ft., by Prof. Rotch, of Blue Hill Observatory, near Boston, Mass.

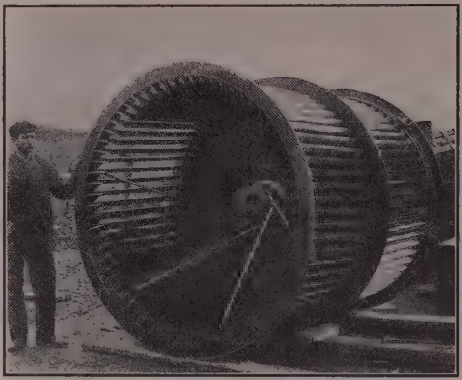
New Ore Shipping Facilities at Seville, Spain.

Reinforced concrete viaducts and wharves have been constructed at Seville, Spain, on the Guadalquivir River, by the Cala Iron Co. to increase its facilities for shipping large quantities of ore. The basin of the river at this point is 3 miles wide between flood levels and only 430 ft. wide at low tide, with a depth of about 21 ft. At low tide the high ground on the side of the new structures is 1,600 ft. from the water's edge. The intervening flats are beds of mud mixed with some sand and gravel. At the edge of low water are two loading piers built of reinforced concrete, with their loading platforms 49½ ft. above low tide. These are approached over the flats by two reinforced concrete viaducts, one for loaded and the other for empty cars, the latter being run back from the piers by gravity. The piers are built on vertical columns, some 89 ft. long, braced by two sets of horizontal struts. The lower part of each column consists of a concrete pile about 12½ in. square which was jetted and driven into place. Each pier has two platforms; the upper one, carrying a 10-ton crane and a tipping apparatus for 20-ton cars, is designed for a floor load of 736 lb. per square foot and the lower one affording easy access to ships, is designed for a load of 184 lb. per square foot. The approach viaducts were designed to carry a train made up of a 22-ton locomotive and twenty 20-ton cars, but they have safely carried much greater loads.

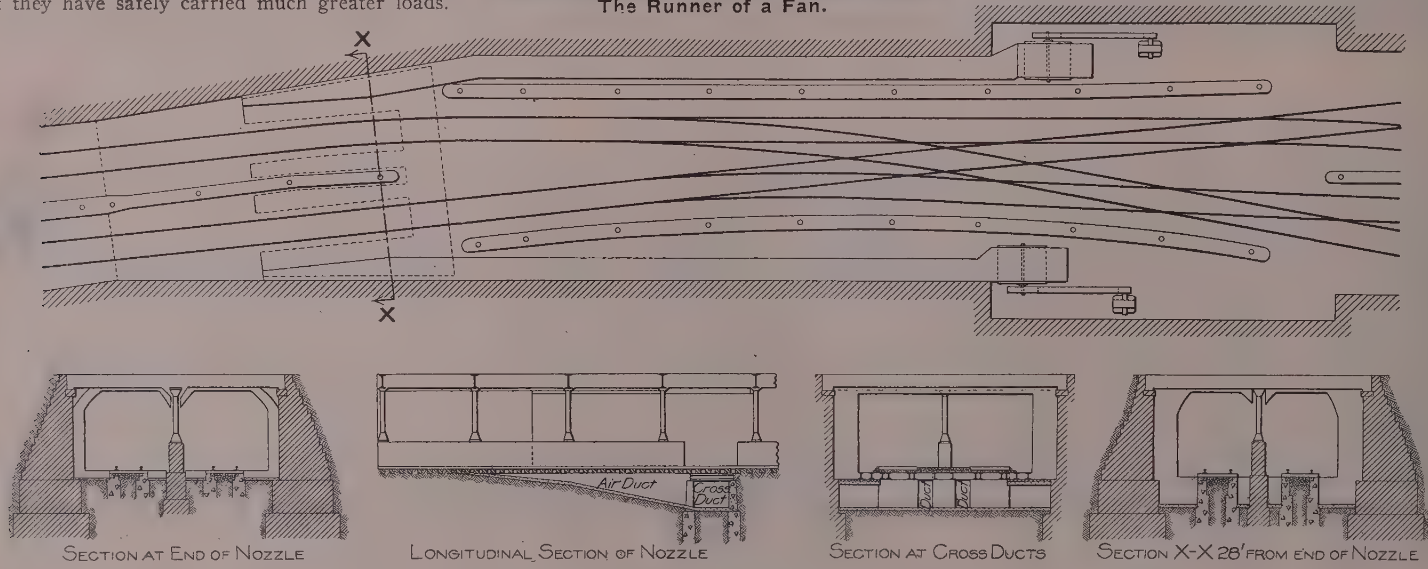
In preparing plans for these structures care had to be taken to reduce obstruction to the flood flow as much as possible. The two viaducts are substantially alike in details. They are parallel and about 6 ft. apart in the clear. Each is made up of a track platform supported on a pair of longitudinal girders about 5 ft. on centers, which in turn are supported on column bents about 29 ft. apart. The bents are braced internally with horizontal struts, but there is no bracing between bents, but the connection between column and girder is of the double bracket type. This arrangement has proved entirely satisfactory; the viaducts have withstood severe tests and at the same time flood water is not obstructed. The main girders are about 47 in. deep and 9 in. wide; the columns are 26 x 9 in. and each bent is founded on a spread footing of concrete designed to reduce the unit pressure to ½ ton per square foot. The two concrete approaches are 384 and 286 ft. long respectively. The tracks are 1 meter gauge with 65 lb. rails according to "Engineering," London, from which these notes have been taken. Don Juan M. de Zafra designed the structure.

Ventilation of the Washington Terminal Tunnel.

Ventilation of the tunnel through which trains reach and depart from the new Union Terminal at Washington, D. C., has been accomplished along lines and by methods that make the installation of special interest. The problem was that of removing from the tunnel all trace of gas and smoke left by one passing train before another train should enter the tunnel. This called for a high output of air, although the circumstances were such that the ventilating apparatus must be confined to a very small space and attain high efficiency at low expenditure of power.


The Runner of a Fan.

At a point about 300 ft. from the terminal portal there were constructed two ventilating ducts, each about 5 ft. wide, which are carried along both side walls of the tunnel to the full height of about 18 ft., with a cross-duct under the tracks as shown. The space available for the fans on which was imposed the duty of clearing the tunnel of smoke in a few minutes, was 18 ft. high by 13 ft. wide. The specifications imposed by the Pennsylvania Railroad Co. called for two fans 120 in. in diameter, each capable of delivering 260,000 cu. ft. of air per minute against a 1½-in. water gauge. The speed was not to exceed 145 r. p. m. and the power requirement was limited to 120 h.-p.



Section at End of Nozzle
Longitudinal Section of Nozzle
Section at Cross Ducts
Section X-X 28' from End of Nozzle

Location of Ducts and Fans for Ventilating the Washington Terminal Tunnel.

The fans installed are of the Sirocco design, with double inlets corresponding in dimensions, efficiency, speed and power requirement to the specifications just noted. These fans, driven by electric motors, have now been in use for several weeks, and have satisfactorily performed the duty imposed upon them. A peculiarity of this type of fan is that it has been found that in all diameters the best results are obtained from 64 blades. It will also be noticed that the blades are very short radially, being only one-sixteenth of the diameter of the fan. Axially, however, the blades are unusually long, three-fifths of the diameter.

The outer edges of the blades are bent forward to a set angle in the direction of rotation, and are very slightly cupped. The inlet and outlet of the fans are practically equal to the area of the fan itself. The special advantage claimed for the size and shape of the blades is that power-absorbing eddies are almost entirely eliminated and the velocity of the air so greatly accelerated that it actually exceeds the peripheral speed of the blades by as much as 70 per cent. The intake draft of the fan is stated to show practically no variation over its entire area. How important these features are is shown by the fact that for the Washington installation no fan of the ordinary type less than 17 ft. diameter could be found that would produce the output of air required, and the space available did not permit the use of a fan of this size. The equipment has been furnished by the Sirocco Engineering Co., of New York, of which Mr. Wm. G. Redfield is president.

Weed Destruction by Burning on the Union Pacific R. R.

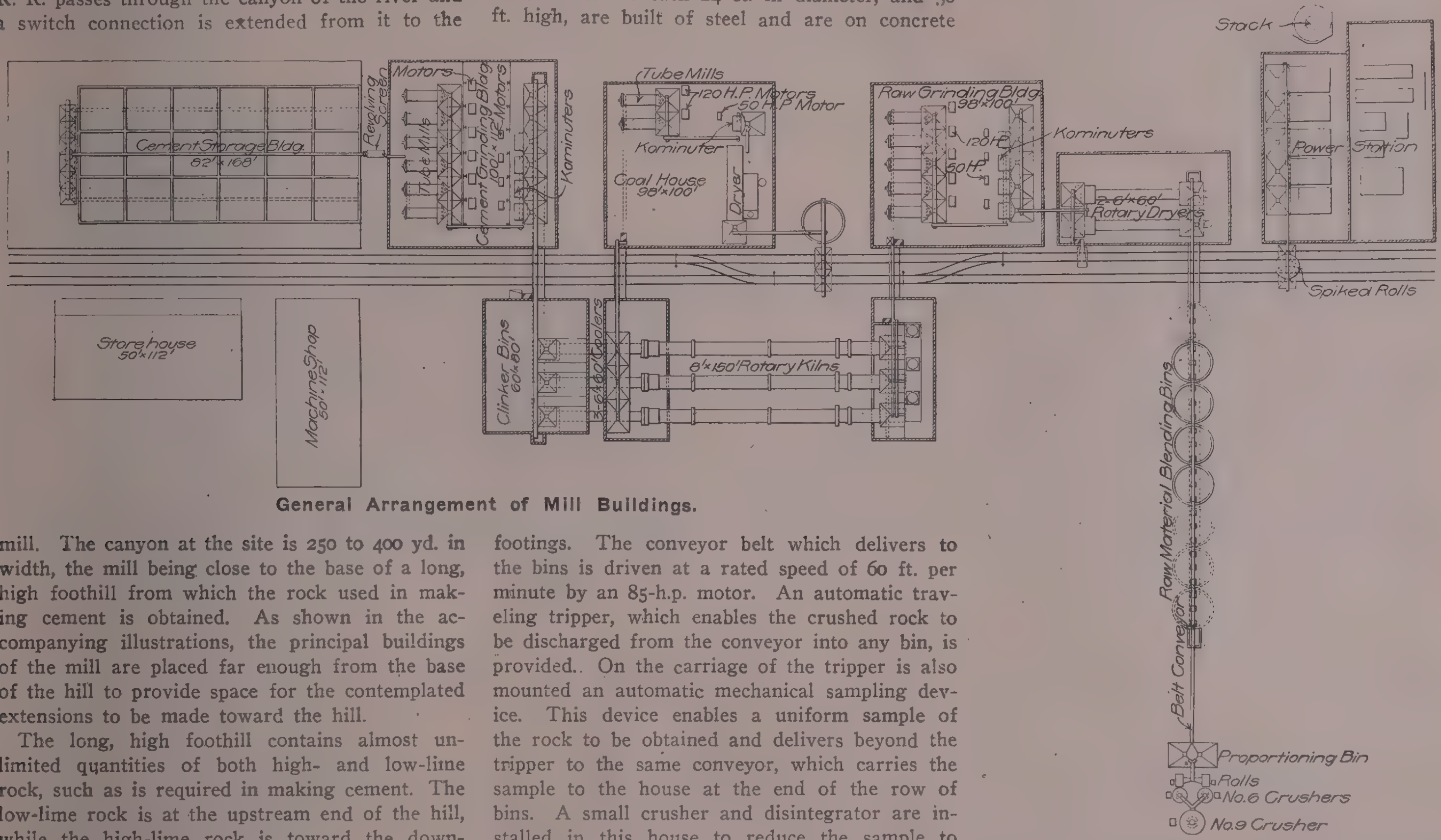
A gasoline weed burner has been built by the Union Pacific R. R. at its Omaha shops which was successfully operated during the past summer. It is a four-wheel truck carrying three large gasoline tanks, a reversible gasoline propelling engine and overhanging weed burners and shields at one end. The burners are arranged in three sections, one for the center of the track and one overhanging at each side. The side sections are adjustable for passing guard rails and wing fences at cattle guards, being raised by compressed air cylinders. The gasoline is fed to the burners, of which there are 18 on each shield, by compressed air, and from 12 to 20 gal. of the fuel is consumed per mile of track covered. About 25 miles of track was ordinarily covered per day at an average cost of $2.70 per mile, including fuel, labor and supplies. Weeds are killed on the Union Pacific by the two-burning method, the first burning merely wilting the weeds, which are then run over a few days later to thoroughly burn them.

The Chicago Freight Tunnels of the Illinois Tunnel Co. have been connected with the freight depots of eleven railroads entering Chicago and connections to seven other roads are now under construction. The company delivers to many stores and warehouses directly through underground connections.

The New Mill of the Union Portland Cement Co.

The Union Portland Cement Co., of Ogden, Utah, has recently placed in operation at Devil's Slide, in the northeastern part of that state, a cement mill with a rated capacity of 2,500 barrels a day. All parts of the mill are arranged, however, so this capacity may be doubled by the addition of more kilns and of some minor auxiliary buildings. The equipment of the entire mill is driven by individual electric motors, the alternating-current induction type being used in all cases, except for the kilns, which are driven by direct-current motors. Power is supplied from a central station, the capacity of the latter being sufficient to operate the mill when ultimately extended.

The mill is in very broken, mountainous country, and occupies the narrow canyon of a small mountain stream tributary to the Webber River, the site being just above the mouth of this small stream. The main line of the Union Pacific R. R. passes through the canyon of the river and a switch connection is extended from it to the mill. The canyon at the site is 250 to 400 yd. in width, the mill being close to the base of a long, high foothill from which the rock used in making cement is obtained. As shown in the accompanying illustrations, the principal buildings of the mill are placed far enough from the base of the hill to provide space for the contemplated extensions to be made toward the hill.



General Arrangement of Mill Buildings.

The long, high foothill contains almost unlimited quantities of both high- and low-lime rock, such as is required in making cement. The low-lime rock is at the upstream end of the hill, while the high-lime rock is toward the downstream end, the two kinds being quite distinct. Tracks have been laid in a bench cut along the side of the hill, 60 to 75 ft. above the bottom of the canyon, and quarries opened on the up-hill side of these tracks. At present, the high-lime rock is loaded into 5-ton dump cars by a 70-ton Bucyrus steam shovel, and the low-lime rock is loaded into cars by hand. These cars are all handled in trains to a tipple and crusher house on the down-hill side of the bench cut containing the quarry tracks by a 25-ton Davenport locomotive.

The tipple and crusher house is 50 x 80 ft. in plan, and is on the steep hillside, with one end considerably taller than the other. The tipple is placed in the uphill end of this house, with the track on it at the level of the quarry tracks so the cars may be shunted on it readily.

The hopper under the tipple feeds a No. 9 Gates crusher, driven by an 85-h.p. motor. Two No. 6 Gates crushers, each driven by a 20-h.p. motor, and two Williams rolls, each likewise driven by a 20-h.p. motor are provided below the No. 9 crusher. The output of the two No. 6 crushers is delivered to either or both of a pair of 400-ton proportioning bins; the rolls deliver to a bucket elevator which discharges into the bins. Provisions are thus made to handle both kinds of rock separately through the crusher house and to proportion them before they are sent to the mill.

The outlet from the proportioning bins is at the base of the downhill side of the crusher house, where the rock is discharged on a 24-in. Caldwell conveyor belt leading to a row of blending bins. This conveyor rises on an inclined trestle for 70 ft. to a height of 33 ft. above the ground, and then extends 200 ft. horizontally at that height on a trestle over the bins. All of this trestle work is of steel and the conveyor is enclosed in a galvanized sheet-iron housing carried by a light steel frame.

Space is provided under the trestle for seven 1,000-ton blending bins and a sampling house. This house and four of the bins have been built, with the intention of erecting the remainder of the bins as the mill is extended. The existing bins, which are each 24 ft. in diameter, and 30 ft. high, are built of steel and are on concrete footings. The conveyor belt which delivers to the bins is driven at a rated speed of 60 ft. per minute by an 85-h.p. motor. An automatic traveling tripper, which enables the crushed rock to be discharged from the conveyor into any bin, is provided. On the carriage of the tripper is also mounted an automatic mechanical sampling device. This device enables a uniform sample of the rock to be obtained and delivers beyond the tripper to the same conveyor, which carries the sample to the house at the end of the row of bins. A small crusher and disintegrator are installed in this house to reduce the sample to proper size for testing.

A concrete-lined tunnel, 10 x 10 ft. in cross section, extends longitudinally under the row of bins, and is continued beyond the end of this row, under two railroad switch tracks and under one end of a 54 x 100-ft. dryer house to the foot of an open elevator in the latter. This tunnel contains a gravity overlapping Link-Belt bucket conveyor, which has 18 x 24-in. buckets, and is driven by a 30-h.p. motor. Crushed stone is delivered to this conveyor through gates in the bottom of the blending bins. Five of these gates, which are of a special automatic feeding type, driven by the conveyor and designed to deliver fixed quantities of material to the latter in a given time, are provided in the bottom of each bin.

The 54 x 100-ft. dryer house to which the bucket conveyor delivers is of the same construction and general type as the remainder of the buildings of the mill. It has a structural-steel frame, with sides and roof of galvanized corrugated sheet iron. The eaves of the buildings are high, and the roof is built at a pitch of about 60 deg., with the idea of presenting a sufficiently steep surface to avoid the accumulation of dust. A monitor is extended the full length of the building at the peak of the roof and is provided with louvres in the sides for ventilation. The buildings of the mill are thus all unusually spacious for structures of this type.

The dryer house contains two 6 x 60-ft. Allis Chalmers rotary drying kilns, each gear-driven by a 10-h.p. motor. The bucket elevator to which the conveyor in the tunnel delivers from the row of blending bins raises the stone to two 500-ton storage bins over the charging ends of the dryers, one over each of the latter. The dryers are each fired by a Roney mechanical stoker. Coal for these stokers is delivered to a hopper under the switch track at the side of the building, and is discharged from this hopper to an overhead horizontal screw conveyor by a bucket elevator, the screw conveyor delivering into either of two bunkers over the stokers.

Adjoining the dryer house is a building, 98 x 100 ft. in plan, in which the raw materials are finely ground, the two buildings being separated only 8 ft. The end of the raw-grinding building toward the dryer house contains a row of five 66-in. Smidth kominuters, with space provided for a sixth. In the opposite end of the building is a row of five 5.5 x 22-ft. Smidth tube mills. Each kominuter is gear-driven by a 50-h.p. motor, and each tube mill by a 120-h.p. motor. These motors are all in a space at the center of the building separated from the grinding machines by tight partitions, in order to protect them as fully as possible from the fine dust emitted by the machines. Furthermore, they all have specially-designed housings which are practically dust-proof. These housings are also provided for all the motors in the mill exposed to the dust, as most of them are. In order to provide an additional aid in keeping the motors clean, compressed air is piped from the central power station to all parts of the mill, with a connection at every motor that has been installed, so the dust can be blown out frequently.

The rotary dryers in the adjacent house both deliver to an inclined bucket elevator, which extends through into the raw-grinding building and discharges there on a horizontal belt conveyor. This conveyor extends longitudinally over a row of five 300-ton supply bins above the kominuters, and is arranged to discharge to anyone of these bins. The output from the kominuters is carried by a horizontal 16-in. screw conveyor, in a small tunnel under the floor to an inclined bucket elevator at one end of the row. This elevator delivers at the top to a screw conveyor extending the length of a row of five 300-ton bins over the charging ends of the tube mills. The tube mills discharge their product on a screw conveyor laid under the floor the length of the row of mills; this conveyor delivers to a bucket elevator at one corner of the building and the elevator delivers in turn to a screw conveyor on a trestle that leads to a house around the charging end of the cement kilns, the latter being directly across the two railroad tracks at the side of the building.

The coal used in the cement kilns is unloaded from the railroad cars in which it is received into a hopper under the two switch tracks. A crusher is provided under each track so run-of-mine, or lump coal may be reduced. An overlapping gravity bucket conveyor extends transversely under the hopper in a horizontal run, then vertically up to the level of a trestle on which it is carried over the tracks to a circular steel storage bin, 26 ft. in diameter and 26 ft. high, between the raw-materials grinding building and the building in which the coal is ground. This conveyor is arranged to discharge into the bin, or directly to a flight conveyor leading into the coal grinding house; coal stored in the bin is raised to a flight conveyor by a bucket elevator.

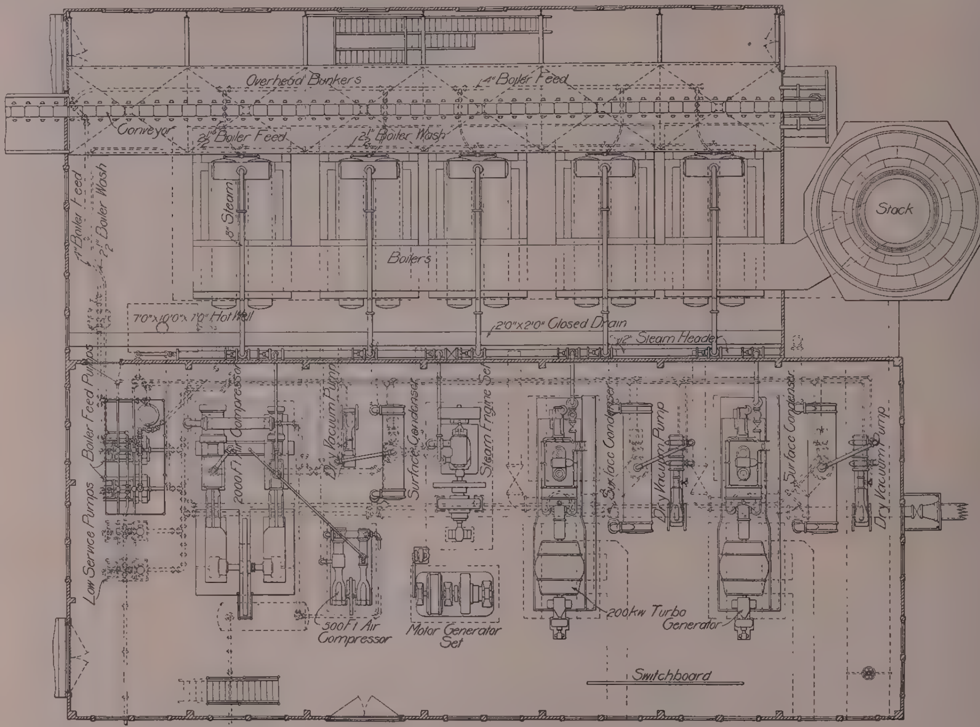
The coal grinding house is 98 x 100 ft. in plan and contains a Cummer dryer, a Smidth kominuter and two 5.5 x 22-ft. Smidth tube mills. The Cummer dryer is driven by a 20-h.p. motor; the kominuter is gear-driven by a 50-h.p. motor and each of the tube mills by a 120-h.p. motor. All of these motors have the specially-designed dust-proof housings. The coal brought in by a flight conveyor is delivered to an overhead supply bin at the charging end of the dryer. The latter is fired with a mechanical stoker and delivers to a bucket elevator which discharges into an overhead supply bin for the kominuter. A bucket elevator carries the output of the kominuter to supply bins for the tube mills, and the pulverized coal from the latter is carried by a screw conveyor at the ground level to a bucket elevator in one corner of the building; this elevator discharges on a screw conveyor on a trestle leading to the firing ends of the cement kilns across the tracks.

The three cement kilns which have been installed were built by the Allis-Chalmers Co. and have several unusual features of design. They are 8 ft. in diameter and 150 ft. long, and with the exception of houses over their ends, are not enclosed. Each kiln is carried at three points by ring bearings and is belt-driven through gears by a 50-h.p. direct-current motor in a small house at one side of the kiln. The ring bearings each rest on rollers on a masonry pier without any housing. The shells of the kilns were especially designed to meet the long spans and other unusual conditions introduced.

The house around the charging ends of the kilns is 40 x 84.5 ft. in plan. In this house a supply bin for the prepared rock is placed over the end of each kiln; the masonry connection between the kilns and the stacks which serve them are also enclosed by the house.

The discharge ends of the kilns are in a building of the same size in plan as the one just described. Pulverized coal is fired into these ends, under an air pressure of about 100 lb. per square inch, from an overhead supply bin for each kiln, through either or both of two supply pipes. The clinker is discharged from each of the kilns directly into a 6 x 60-ft. cooler under the floor of the building. A spray of water is applied to the clinker in these coolers and the resulting steam is carried off by a stack outside the building, in order to prevent it from reaching the kilns.

A clinker bin, 60 x 80 ft., in plan, is provided at the discharge ends of the kilns. An overlapping gravity-bucket conveyor extends from this bin across the two railroad tracks between the kilns and the principal buildings of the mill to a 100 x 112-ft. cement grinding building. The lower horizontal run of this conveyor passes along in front of the discharge ends of the clinker coolers, where it receives the clinker directly from the latter, thence through a tunnel under the tracks and under the cement-grinding building, at the farther end of which it rises vertically and returns in an upper horizontal run to the clinker bins. This return run is carried over a row of five 300-barrel elevated storage bins in the building, and outside the latter is on a trestle. When the clinker requires seasoning it is carried through the building and back to the clinker bins, from which it can be drawn into the lower run of the conveyor as desired. Otherwise it is delivered directly from the kilns to the supply bins in the building.



Plan of Power House Building, Union Portland Cement Co.

The cement grinding building contains four No. 16 Lindhard kominuters with space provided for two additional ones, and six 5.5 x 22-ft. Smidth tube mills. The kominuters are each driven by a 50-h.p. motor and the tube mills each by a 120-h.p. motor. The arrangement of these motors is the same as those in the raw-grinding building. The conveying apparatus in this building is also arranged practically the same as that in the raw-grinding building. The finished cement from the tube mills is delivered by a screw conveyor, placed transversely under the outlet end of those mills, to an inclined bucket elevator that discharges at the top into a screw conveyor extending into the cement storage building, the two buildings being separated only 16 ft.

The cement storage building is 112 x 210 ft. in plan and contains three rows of circular steel tanks, with three tanks to a row. These tanks have a capacity of 3,500 barrels each, making the total storage capacity 31,500 barrels, and additional capacity for 70,000 barrels is being constructed. The screw conveyor from the cement grinding building extends over-head the length of the middle row of tanks, and has spouts leading to the tanks in all three rows. The cement is drawn from the bottom of the tanks through five automatic gates into a screw conveyor placed longitudinally under each row of tanks. These three conveyors all deliver at the same end to a cross conveyor, which delivers in turn to a bucket elevator; the latter raises the cement to the top of the building, where it feeds a screw conveyor that extends the length of a row of six elevated bins, each supplying automatic weighing and sacking devices. The filled sacks are loaded directly into the cars from these devices.

The central station from which power is supplied to operate the entire mill is complete and modern in every way. It occupies a separate building, 100 x 112 ft. in plan, at one of the group of mill buildings. This station building is of the same construction as the remainder of the mill buildings, and is divided on the longitudinal center line by a tight partition into a boiler room and an engine room, with reinforced concrete floors.

The boiler room contains five 500-h.p. Heine water-tube double-drum safety boilers in a single row. The furnace of each boiler is equipped with a Roney automatic stoker, supplied with coal by gravity from a separate overhead bunker holding about 125 tons. Coal is delivered to this row of bunkers from a hopper under the switch track along one end of the building by an overlapping gravity Link-Belt bucket conveyor. This conveyor extends from the track hopper vertically up to a trestle over the tracks, then horizontally on this trestle into the building and along over the elevated bunkers; at the end of the row of bunkers it drops vertically to a basement under the firing floor and in this basement has a horizontal run leading back to the track hopper. The ashes from the furnaces are also handled by the conveyor, which delivers them to an overhead storage bin close to the track end of the boiler room, so they can be loaded into cars readily

The boilers are supplied with feed water by either of two 10 x 6 x 10-in. Fairbanks Morse boiler-feed pumps in the basement at one end of the engine room. These pumps draw from a 7 x 10 x 7-ft. hot well in the basement of the boiler room or from a Wainwright feed water heater adjacent to the pumps. A 4-in. connection is carried from the pumps under the floor to the firing room floor, and thence along under the latter, with a connection to each boiler. Each boiler is also provided at the front with a 2½-in. washout connection. The supply line for these connections is furnished with water by either of two service pumps in the basement of the engine room, and is suspended from the under side of the floor of the engine and boiler room. Each boiler is also fitted with a blow-off connection which discharges into a closed box drain, 2 x 2 ft. in cross section, which is built in the basement of the boiler room, under the space in the rear of the boiler settings. This drain is contained transversely under one end of the engine room and discharges into a waterway leading to the creek.

The boilers each have an 8-in. steam connection to a 12-in. steam header suspended along the boiler room side of the partition, on brackets, 16 ft. above the floor line. These connections are each taken from a steam chest over the front ends of the two boiler drums and have a gate valve at this chest and also at the steam header. The latter is also equipped with a gate valve so it can be divided into two sections. Each of the main steam-consuming units in the engine room has a separate connection to the header.

Mill Buildings Looking toward the Quarry.

Mill Buildings Looking from Quarry Hill.

The principal equipment of the engine rooms consists of the following units: Two 1,500-kw., 3-phase, 30-cycle Westinghouse turbo-generator sets; a 250-kw., 250-volt synchronous Fort Wayne motor-generator set; a 15 x 27 x 16-in. Westinghouse automatic vertical compound engine, direct-connected to a 240-kw., 250-volt direct-current Fort Wayne generator; a cross-compound two-stage Laidlaw Dunn Gordon compressor, having a capacity of 2,000 cu. ft. of free air a minute, and a smaller unit of the same type with a capacity of 500 cu. ft. of free air a minute. In addition to these main units is the necessary auxiliary equipment and apparatus.

The principal part of the load on the station is carried by either of the two turbo-generator sets, which are arranged in identically the same manner. Steam is supplied to the turbines at 200 lb. pressure, the units operating at 1,800 r.p.m. Each turbine exhausts through a 30-in. connection into a separate Alberger surface condenser set on the floor of the engine room. A 20-in. exhaust to the atmosphere is also provided by extending a connection from each turbine into the drain under the rear of the boiler room. Cooling water for the condensers is obtained from the creek and is delivered to the station under a head of 12 ft. by a wood-stave pipe line, extending to the power house from an intake 2,700 ft. up the canyon; the cooling water is discharged into the drain in the boiler room basement, so no circulating pumps are required. The water of condensation is delivered from each condenser to the hot well in the basement of the boiler room by an 8 x 20 x 20 x 12-in. Alberger dry vacuum pump, also on the floor of the engine room at one side of the condenser.

The generator end of each turbo-generator unit is in a dust-proof case, designed specially for this installation. A circulation of air through the generator is obtained by connecting the interior of the case to the atmosphere by a 3-ft. x 3-ft. 4-in. duct under the floor of the engine room. The exciter for each of these generators is direct-connected to the end of the main shaft of the unit.

The 250-kw. synchronous motor-generator set supplies power to operate the direct-current motors in the mill and for incandescent lamps of the lighting circuits. As it is arranged it maintains the load factor of the station, but can be operated with the either side as a generator. The 240-kw., engine-generator unit is installed for service in case the motor-generator set is out of commission.

The engine of the 240-kw. unit and the two air compressors are operated condensing, a single Alberger surface condenser, with 1,800 sq. ft. of cooling surface, serving the three. The cooling water is circulated by gravity the same as in the larger condenser. A 6 x 10 x 14-in. Alberger dry-vacuum pump delivers the water of condensation from this condenser to the hot-well. Each of the three units served by the one condenser also has a separate exhaust connection to the atmosphere through the drain in the basement of the boiler room.

The large air compressor supplies air to force the powdered coal into the cement kilns. The smaller compressor is installed as a reserve to prevent a complete shut-down in case the large compressor is out of service. Both compressors deliver to a receiver in the basement of the engine room and air is piped from this receiver to every building in the mill for use in cleaning the numerous motors.

The operation of the various electrical equipments in the engine room and the distribution of power to the different buildings is controlled from a sixteen panel switchboard along one side of the room. This board has two panels at one end for the two turbo-generator units; next to these is a panel for the exciters of these units and then a totalizing panel with a recording wattmeter and a voltmeter. The next nine panels are each for a separate power circuit. Of the remaining four panels, one is for the exciters of the direct-current units, one for each of those units and the fourth is used for the lighting circuits.

Two 10 x 8½ x 12-in. cross-compound Fairbanks-Morse pumps supply water under pressure to a system of distribution mains extending to all parts of the mill. These pumps take suction from a sump which can be supplied from the gravity system, from the hot-well or from a sump in the drain under the boiler room. The exhaust from these pumps and from all of the auxiliary steam-consuming units is delivered to the feed water heater.

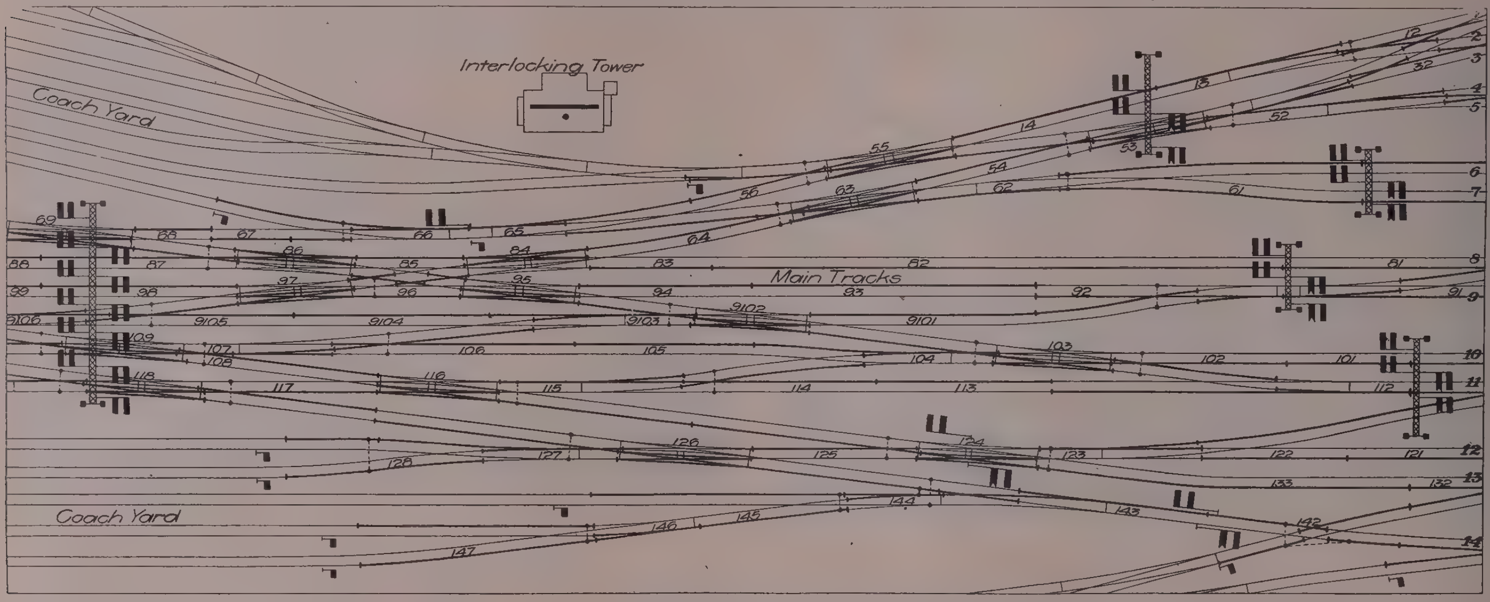
A thoroughly-equipped machine shop building, 50 x 112 ft. in plan and a 50 x 112-ft. store house building have been included in the mill, in order to provide as fully as possible for immediate repairs, since the mill is in such an isolated region that outside shops cannot be depended on for such work. The machine shop contains an 18-in. gap Putnam lathe, a Bickford radial drill, a 20 x 44-in. gap engine lathe, a 36-in. engine lathe, a 48 x 36-in. planer with a 12-ft. table, a pipe machine, a key seater, a bolt machine, a punch and shear, and various auxiliary small tools. All of this equipment is belt-driven from a line shaft by either a 20-h.p. direct-current or a 20-h.p. alternating-current motor, the two being provided so power will always be available. An unusually large supply of extra parts is kept in the store house, since the delivery of such parts from eastern manufacturers is slow.

A 40 x 65-ft. two-story and basement office and laboratory building, built of concrete, was erected adjacent to the power house. The basement and part of the first floor of this building contain a very completely equipped laboratory for making all standard chemical and physical tests of the raw materials, clinker and cement. The balance of the first floor is given over to the offices. The top floor contains a drafting room and quarters for the superintendent and office employes. The company has also built a new town, about a mile down the canyon, for the mill operatives. All of the houses in this town are of concrete, and are supplied with water from a gravity system in the hills. Electric lights and a complete system of sewers are also provided.

The officers of the Union Portland Cement Co. are as follows: Messrs. C. W. Nibley, pres.; Jos. Scowcroft, Reed Smoot and M. S. Browning, vice-presidents; James Pingree, secretary and treasurer and O. B. Gilson, manager. In addition to the contractors which have already been mentioned, the American Bridge Co. furnished and erected the steel-work of the buildings and the Ft. Wayne Electric Co. built and installed the motors throughout the mill.

New Route-Locking System of Interlocking Signaling, Hoboken Terminal, Lackawanna Railroad.

Within a little over two years, the entire passenger facilities of the Hoboken terminal of the Delaware, Lackawanna & Western R. R., at Hoboken, N. J., have been wholly remodeled and reconstructed. In the modernization of facilities as well as keeping pace with the rapidly growing traffic, a large new station building and ferry house have been built, which, together with the new and original type of train shed, with 14 tracks in it, have been described in articles in The Engineering Record for June 24, September 30 and November 11, 1905. The new train shed, replacing an original shed having but nine tracks, necessitated extensive changes in the yard trackage layout, which changes were further affected by the provisions necessary for handling the increased number of simultaneous train movements, that will result in the near future upon the completion of the second tunnel through Bergen Hill to connect with the two main divisions of the system to the west. The construction of the new Bergen Hill tunnel and its effect on traffic were referred to in The Engineering Record for January 12, 1907.



Central Portion of the Passenger Yard at the Hoboken Terminal of the Delaware, Lackawanna & Western R. R.

The yard layout has, in fact, been entirely revised, the effect of the increased number of trainshed tracks as well as of the new Bergen Hill tunnel connections being such as to render almost all of the original yard unsuited to the new conditions. There are at the present time about 125 scheduled passenger train movements in either direction per 24 hours, regardless of the very large number of unscheduled yard engine and train shifting movements, it being estimated that there are from 1,200 to 1,500 movements necessary in this yard per 24 hours under present conditions of traffic. The large proportion of the traffic is that involved in handling the suburban travel, to and from New York at morning and evening, which heavy traffic it is the desire to relieve materially when the new tunnel is completed and the four-track connection completed through the hill, by multiple train movements simultaneously in either direction. That is, during the morning inbound travel, the two inner of the four tracks will be used as well as the main eastbound track for eastbound movements, while at the evening "rush hour" period, the two inner tracks will be used with the main westbound track for westbound movements. These conditions have demanded a design of yard and interlocking plant that will permit of several simultaneous through movements, without interference, the result of which, after a careful study of the requirements, is the trackage layout here illustrated.

The yard layout adopted is considerably broken up, in the vicinity of the passenger terminal, by the location of the coach yards on either side, there being an 18-track coach yard with Pullman and immigrant track connections to the south, and a four-track express yard, a 10-track coach yard, and round house connections on the north side, the arrangement of which is such as to render a large number of crossovers and switching connections necessary. There are in this portion of the yard a total of 36 switches and 23 double slip switches and one single slip switch which it is necessary to protect for through movements. This section of the yard, which is about 2,000 ft. in length and handles no freight traffic, being confined solely to passenger train and switching movements, is controlled from an interlocking tower on the northerly side of the yard about 600 ft. west of the west end of the train shed. The connections from the main line to the large freight yard which lies to the south of the passenger terminal are made from the extreme westerly end of this yard near the entrances to the tunnels under Bergen Hill, and are controlled by a separate tower of much smaller size.

The switching and signaling for the main tracks and connections in this division of the yard is operated by an interlocking equipment on the Westinghouse electro-pneumatic system, which embodies the usual features of electric control of switch and signal movements and mechanical locking, but in which at the same time there has been added the new feature of route locking applied by means of track circuits. The use of the latter track circuits, while complicating considerably the electrical connections involved in the system, takes the place of and obviates the necessity of using the usual track detector bars which has the effect of great simplifying the track maintenance in the yard and freeing it in a very advantageous manner from obstructions. With the exception of the use of a new form of relay, however, there is no other change to be noted in the form of apparatus as manufactured for this system by the Union Switch & Signal Co. The control of the yard is, as above stated, placed in a signal tower some 600 ft. to the west of the west end of the train shed and in a central location to the north of the converging tracks. In this tower there is installed an interlocking machine with a 131-lever frame, together with an indicator board for the announcement of and signaling to trains in the 14-track train shed. These are located in an operating room on the third floor of the tower, a 20x35-ft. building of reinforced concrete construction, which contains on its second floor level, a relay room in which are the repeater and route locking relays located at the tower and an office for the yard master and supervisor of signals, and on the lower floor level, a storage battery room, the generator room and a repair shop. The equipment of the tower is that which is usual for the control of trains to and from the train shed. There is a 14-way indicator at the top of the indicator board which shows by means of miniature semaphores which tracks in the train shed are occupied by trains. Under this indicator board are located a 14-drop disc train annunciator, by means of which signals are sent to the tower men as showing the track in the train shed on which a train is ready to start, and under this a series of push buttons for operating the clearing signals at the entrance to the train shed when a route is given to any train, and telephone connections for communication with the train shed and other parts of the yard. Announcements of trains approaching from the west are also signalled on this board by a 16-way train describer that is operated from the interlocking tower at the westerly end of the yard near the entrance to the tunnels.

The interlocking machine is fitted with 66 switch levers and 65 signal levers, of which 55 of the former control 36 switches and 23 double slip switches and one single slip switch with movable point frogs, and 44 of the latter control 105 signals. Thus 99 of the levers are working levers, while 11 switch levers and 21 signal levers are held in reserve for future extension; these levers being, in fact, distributed quite generally throughout the frame so as to facilitate changes in the yard layout as well as to provide for increased connections on either end of the yard. The machine has a complete working track model of the yard mounted above it, which, as shown in the accompanying illustration, indicates the position of all switches in the yard at all times. The general details of construction of the machine and its method of operation do not, however, differ from those of the standard electro-pneumatic machines as made by the Union Switch & Signal Co., there being, in fact, but two changes in the construction of the machine as affected by the application of the route locking system. One is the addition of extra contact rollers for each of the switch and signal lever shafts in order to provide for the additional contacts required for route locking, and the other, an arrangement of track circuit indication lamps on the lower front side of the machine which indicates when the track circuits are or are not occupied by trains. The extended contact roller is mounted in a vertical position in the lower rear side of the frame and connected with the main switch and lever shaft through a bevelled gear drive in each case. While this arrangement of the rollers and contact plates would appear to be unsuitable, it is, in fact, very convenient, there being ample space available for the contact plates on the rear side of the frame in this position, whereas if the regular horizontal contact plate of the machine had been widened by an extension of the frame and removal of the indication magnets to the rear, the width of the machine would have been so increased as to become inconvenient of access and unwieldy. The track circuit indication lamps consist of a row of one-half-candle-power incandescent lamps arranged under numbered bulls' eyes in a special glass boxing on the lower front side of the frame; these lamps have been inserted to correspond to the switch levers only, and are correspondingly numbered, the lamp for each switch being directly underneath its lever. These indication lamps are lighted and extinguished by the action of the track circuits directly, short direct connections being taken from the switch handle contacts within the front of the machine frame, which so operate as to extinguish the lamp when a route is locked up and a train is passing through it, and lights the lamp again when the train has passed through the track circuit and cleared the switch, the lamps remaining lighted as long as their switches are clear.

Westerly Portion of Yard and Large Signal Bridge.

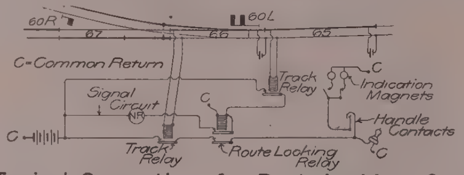
Route locking, which is the essential new feature of this plant, is an application of the track detector circuit method of protecting switch movements instead of the usual track detector bars. At the same time, the use of these circuits provides for an interlocking which enables certain combinations of routes through the yard net work to be locked up for the passage of trains through them. The use of the track detector circuit scheme is not new, and it has, in fact, been applied in a few cases for the control of certain trackage combinations or routing, but this is the first plant in which a complete interlocking layout has been fitted with the track circuits to the entire exclusion of the usual detector bars. Route locking is effected by the grouping of the track circuits covering switches or sections of track in varying combinations for the different routes through the yard, and so controlling the lever movements of the machine which cover the route, that after once being locked up, no changes can be made in any part of it until the train affected has passed through. This locking is accomplished by the agency of track circuit relays which operate through six-point repeating relays of a new design to control electro-magnetic locking mechanisms on the switch levers. For simplicity the indication magnets are made use of for the latter purpose, but slight changes in the segments on the lever shaft into which the indication magnet armatures engage, being necessary for the desired locking. The inclines on the outer sides of the detent notches of the segments are merely replaced by full notches with square shoulders which prevent the return of the lever after having been thrown its full stroke instead of the opposite, as in the usual machine construction.

General View of the New Station Yard from Large Signal Bridge.

The locking control is accomplished by passing circuits in series through points on certain of the six-point relays for the various switches covered in any particular route and connecting them through contact roller points of the levers into the indicating circuits of the machine levers which it is necessary to lock for completing the route. The connections involved are all made through the special contact plate and points on the rear of the frame, there being as many as 14 contacts on the rollers of some levers for the route-locking combinations. With this arrangement the switch levers are equipped with latch circuit controllers similar to those applied to the signal levers, which are connected into the relay contact circuits, but normally hold the indication magnet circuits open. Then on the first movement of the lever latch, which closes this contact, the indication magnets are energized, provided, however, that the track sections composing the route are not occupied by a train. The lamps arranged on the front of the machine frame to indicate to the tower men whether the track circuits locked up into a route, are occupied or not, are, for every switch lever, energized by the same indication circuit that is brought through its latch circuit controller to actuate the indication magnets. When a route is locked up and the detector circuits de-energized by the entrance of a train into the route and consequent opening of the track circuit relays, the lamp is extinguished, but as the train passes through the route and the track circuit relays close again, the various lamps light up again and indicate what parts of the route are again free. The positions of passing trains are thus clearly indicated at the machine and operation is for this reason as certain in fog or at night, as in clear daylight.

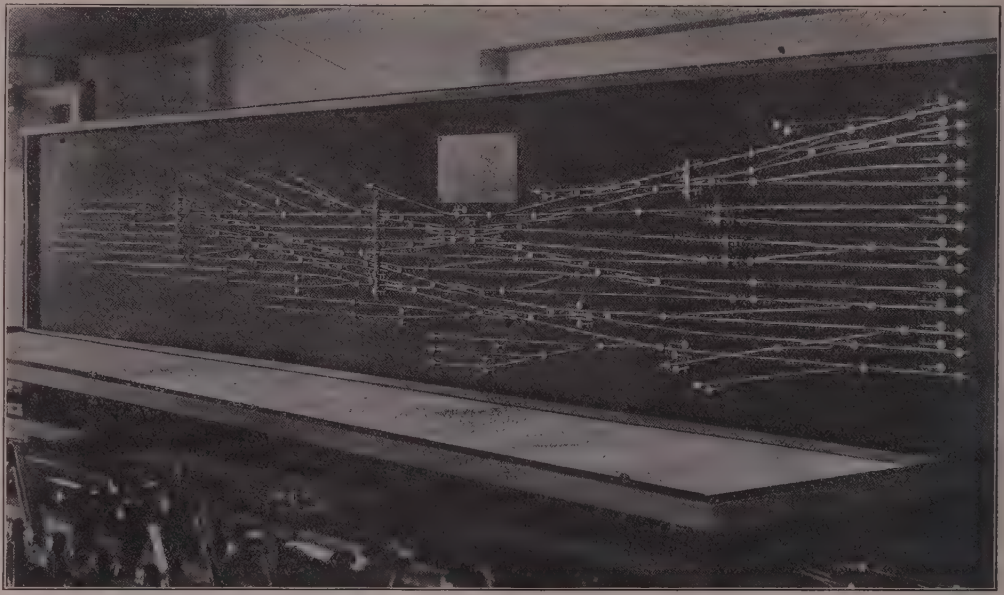
An advantage of this method of switch lever control as here applied, consisting of the control of the switch levers by individual control circuits which cover all of the switch lever combinations that its movements may affect, and the control of these individual circuits by the six-point route locking relays for the various route combinations, is that, as rapidly as a train in passing through a particular route, clears the track circuits involved in any one of the switch lever control combinations, the switch lever controlled thereby is at once freed, and may be immediately thrown for any new train movement desired. Another of the advantages of this system is, as has been heretofore stated, the simplification of the track work in the yard by the omission of the detector bar connections; the effect of this being clearly shown in the accompanying photograph. During the winter, the packing of snow between the detector bars and rails causes frequent delays and requires constant attention; this source of trouble is entirely eliminated with the route locking system.

The auxiliary equipment of the plant differs little from that usually installed with the exception of the repeating relays which, owing to the large number of contacts required for the various circuit combinations are of a new form of construction to provide for six front contacts. The details of construction of this new relay are exactly similar to the four-point relay of the Union Switch & Signal Co., the principal difference being the change of the form of the base from round to square which enables the two extra contact fingers to be added to the armature. The same form of magnet and armature construction and of contact insulation is used while the base has a square glass enclosure. Although all of the relays are installed with two back contacts, the system as installed does not involve the use of any of the back contacts. These repeater and route locking circuit relays which are for the greater part operated at a voltage of 16 volts are wound for resistances of 1,000 ohms, while the track circuit relays which work at 2 volts are wound for 12 ohms. The electric supply for the operation of the plant is furnished by two motor generator sets located on the first floor level in the interlocking tower, one of which of 3-kw. capacity, serves for the charging of storage batteries for the track circuits and the repeater circuits, and the other a ½-kw. set, for the delivery of current direct to the machine in emergency cases. The former unit consists of a 60-volt direct-current generator driven by a 5-h.-p. 3-phase induction motor and the latter a 20-volt, direct-current machine driven by 1-h.-p. induction motor. Both sets consist of General Electric Company apparatus and the motors operate on the 440-volt, 60-cycle, 3-phase, alternating-current service supply of the company, used in the yard and terminal.

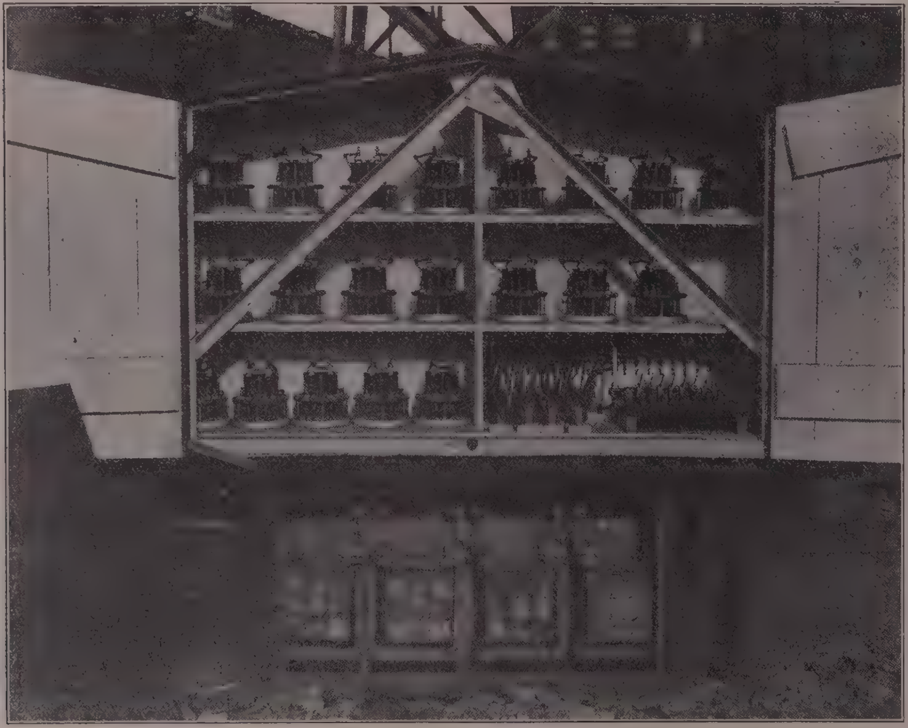


Typical Connections for Route-Locking, Covering a Single Switch.

Interchangeable with the 20-volt generator set for the machine circuit supply, there are two sets of storage battery located in a separate room in the lower floor of the tower, each of which consists of 8 cells of 440 ampere hour Chloride storage battery, the sets being in duplicate to permit of charging without interruption of service. The various track circuits throughout the yard are supplied with current at 2 volts by groups of four cells of 144 ampere hour General Electric Storage Battery Co.'s batteries which are arranged in duplicate sets of two or more cells each in a number of different portions of the yard for short direct connections to the track circuits. There are eight sets of these track circuit batteries, one in the base of each of the six signal bridges, and two opposite the interlocking tower.



Track Model of the Entire Passenger Yard on the Interlocking Machine.



One of the Track Circuit Relay and Battery Boxes in the Yard.

An accompanying illustration shows one of the battery and relay boxes, which is located at the base of signal bridge No. 1. From this point there are 14 track circuits supplied for each of which there is provided a variable resistance coil to prevent excessive flow of current to the track circuit when occupied by a train. Each set of track circuit battery has a throw-over switch for changing the cells from their multiple to series connections for charging purposes. All of the wiring for the plant is laid underground in bituminous conduits which are carried in trunk lines with convenient manholes. Owing to the multiplication of electric circuits required for the route locking circuit system, a total of about 100 miles of wire was required, all of which is of No. 12 copper with a special rubber and braid insulation required to comply with the signal engineer's specifications.

The switch and signal mechanism are of the usual type of construction made by the Union Switch & Signal Co. The apparatus is supplied with compressed air at 90 lb. pressure from a compressor located in the roundhouse power plant in the westerly portion of the yard, although the air supply as well as that of electric power, is soon to be furnished from the new terminal power plant that is under construction at the south side of the yard near the station building. The pressure on the air supply line is recorded by a Bristol pressure recording gauge located in the supervisor's office in the interlocking tower to provide reliable records against which to check up failures of switch movements that may be occasioned by insufficient air pressure. The interlocking tower and all of the signal lamps are lighted by electric lights. Four-candle-power incandescent lamps are used for all signals which are supplied from a system of circuits operated at 104 volts that center in the interlocking tower.

The installation of the interlocking and signalling system has been carried out entirely by the Signal Dept., of the Delaware, Lackawanna & Western R. R. Co. The plant was designed under the direction of the chief engineer, Mr. L. Bush, by Mr. M. E. Smith, signal engineer, and the work of installation was supervised by Mr. W. B. Weatherbee, general signal inspector. The interlocking machine and switching and signalling equipment were furnished by the Union Switch & Signal Co., Swissvale, Pa. The work of installation was begun in June, 1907, and with a force of from 40 to 45 workmen, electricians and mechanics, required about 6 months to complete, the plant being placed in operation on December 1st. The maintenance force consists of a foreman and two repair men who are on duty during the day time and two repair men on duty at night.

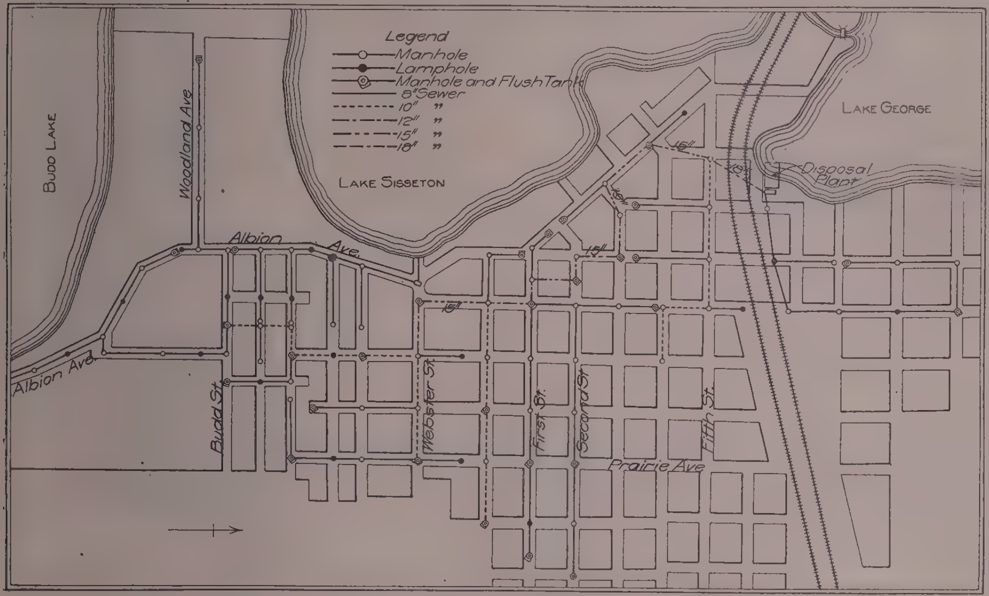
Shaft Lining for Water-Bearing Soils.

A new method of lining shafts through water-bearing soil is reported from France in the U. S. Consular and Trade Reports. The lining, or tubbing, is costly and difficult in deep shafts and the cast-iron rings heretofore used have been made thicker and thicker as the pressures increased. The new method uses an iron ring ¾ in. thick, lined inside with reinforced concrete of a thickness and strength to carry the pressure, the iron ring serving merely to protect the concrete from the water. The thin iron tubbing is put in place, and faucets are placed at intervals to give exit to the water behind the tubbing, which might interfere with placing the cement lining. When the latter has hardened, the faucets are closed. Subsequently, cement grout is forced through these faucets behind the tubbing to insure a tight seal. It is claimed that the system allows repairs to be made with ease, for if water finds its way through at any point, the faucets in that neighborhood can be opened to relieve the water pressure, and the annular section of cement lining demolished and rebuilt. This can be done without suspending hoisting operations, if the shaft be of fairly good size. In cases where iron rings 4¾ in. thick were formerly used the saving in metal by the new system is about 20 tons per meter of shaft, the latter being 6 meters or 19.8 ft. in diameter. The difficulties of manufacture and handling rings over 4¾ in. thick, even when in quite small sections, are likewise obviated with this system, the iron tubbing being the same thickness for all pressures.

Sewerage and Sewage Disposal at Fairmont, Minn.

By A. Marston.

The city of Fairmont, Minn., has a population of about 3,000. It is located along the eastern shores of three small connected lakes, all at the same level. The ground is rolling and the surface drainage flows along three natural depressions into Budd Lake, a short distance south of the territory shown in the accompanying general map, into Lake Sisseton at Webster St., and into the southern end of Lake George. Budd Lake is the source of the city's water supply. The outlet of the chain of lakes is at the northwestern end of Lake George.

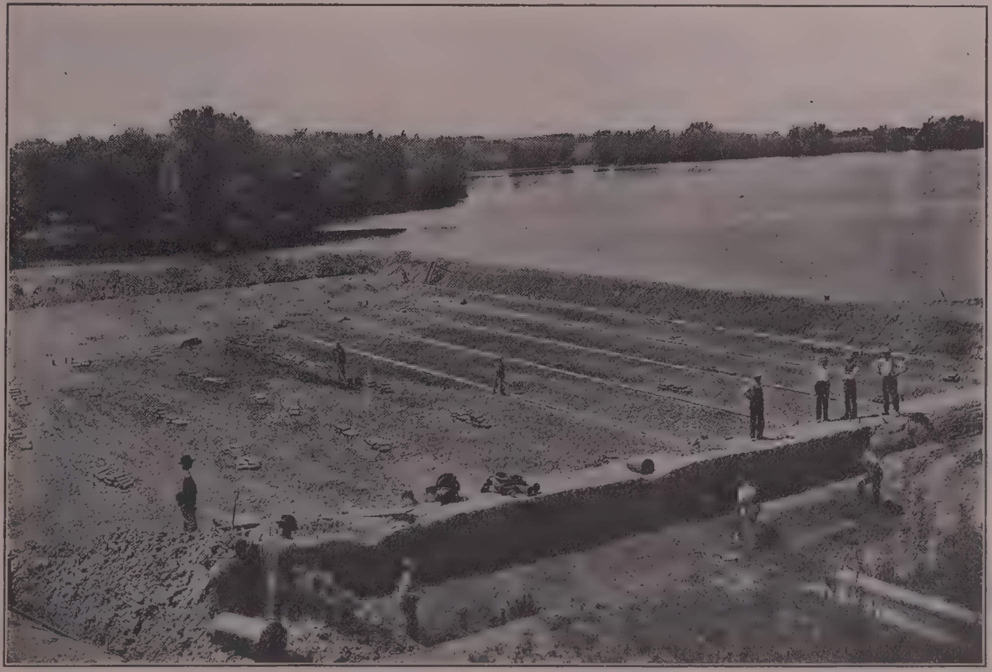


General Plan of Sewerage System, Fairmont, Minn.

The comparative length of the tract to be sewered, the low surface elevations adjacent to the widely separated natural drainage outlets, and the comparatively high surface elevations of the intermediate ridges, made it very difficult to secure a satisfactory gravity outlet at a single point, especially if pumping all the sewage was to be avoided at the sewage disposal plant. A previous plan met this difficulty by providing for about three-fourths of a mile of cast-iron outlet sewers, submerged in the lake to depths of 10 to 12 ft. much of the way, and meeting at a sewage disposal site on the opposite shore.

In 1905 the writer was employed to prepare a new set of sewer and sewage disposal plans. Difficulties in securing land for sewage disposal purposes at other possible outlets, made it necessary, finally, to locate the outlet at the south end of Lake George, as shown on the map. To take advantage of the lowest ground, while serving adjacent property all the way, a somewhat circuitous route was adopted for the 15-in. outlet sewer from Webster St. to Fifth St. This sewer has a maximum depth of 24 ft., from First to Second Sts. Although laid at a grade which will be self cleansing when the flow is increased by the construction of the entire system, the light flow to be anticipated for several years made it advisable to provide for automatic flushing of this main sewer by locating 500-gal. flush tanks at intervals of two to three blocks. These flush tanks are operating with entire satisfaction.

The portion of Albion Ave. between Budd and Webster Sts. was too low to be sewered by gravity through the above outlet sewer, and for this and for a similar small region on Prairie Ave., sewage lifts consisting in each case of a No. 2½ vertical centrifugal pump driven by an electric motor were specified. The sewer and sewage lift on Albion Ave. are being built the present year, but the city has, on its own responsibility, substituted a water motor for the direct-connected electric motor originally provided by the engineer. An automatic starting and stopping device was also planned by the city authorities. Electric power would have been available at night only. Both the water-works system and the electric light plant are owned by the ctiy.

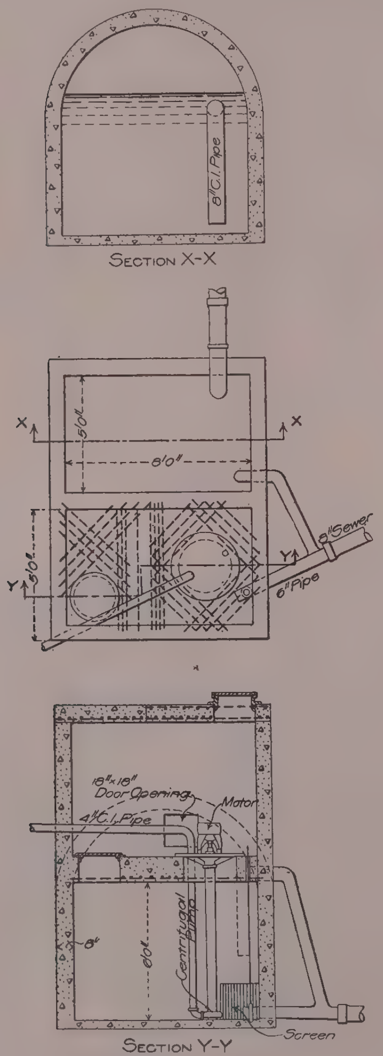


The Fairmont Sewage Filters under Construction.

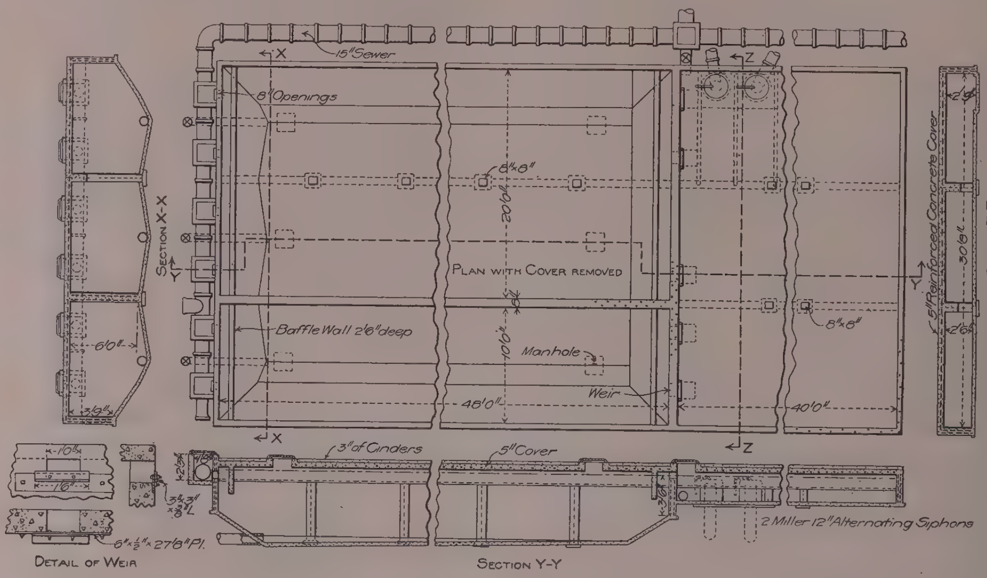
It was, of course, absolutely inadmissible to discharge the sewage of the city into one of the pretty lakes, forming the only available outlets, without thorough purification. The lake shore is closely built up, or reserved for parks and summer cottages, so that it was difficult to secure land for disposal purposes on the side next to the city, while the expense and uncertainties of submerged sewers and the steepness of the banks were serious objections to the opposite shore. The site finally adopted lies at the foot of a steep shore to the east and a high railway embankment to the south; three dwellings are located only about 200 ft. away. The plant consists of a concrete septic tank, holding about 80,000 gal., and of two intermittent sand filters, with a total area of 26,000 sq. ft. of filtering surface.

The main features of the septic tank are typical of several recently designed for various places by the writer, and may be enumerated as follows: The division of the main tank into two compartments of unequal size, the large dosing chamber to insure uniform distribution over the filters, the inlet arrangement for uniformly distributing the entering sewage, the outlet weirs from the main tank, the use of alternating siphons in the dosing chamber, the sloping tank bottom, diminishing the height of the sides of the tank, the flat concrete roof close to the sewage line, and the gravity outlets for the sludge. All of the above features have been tested in the actual operation of plants designed by the writer and are found to work well.

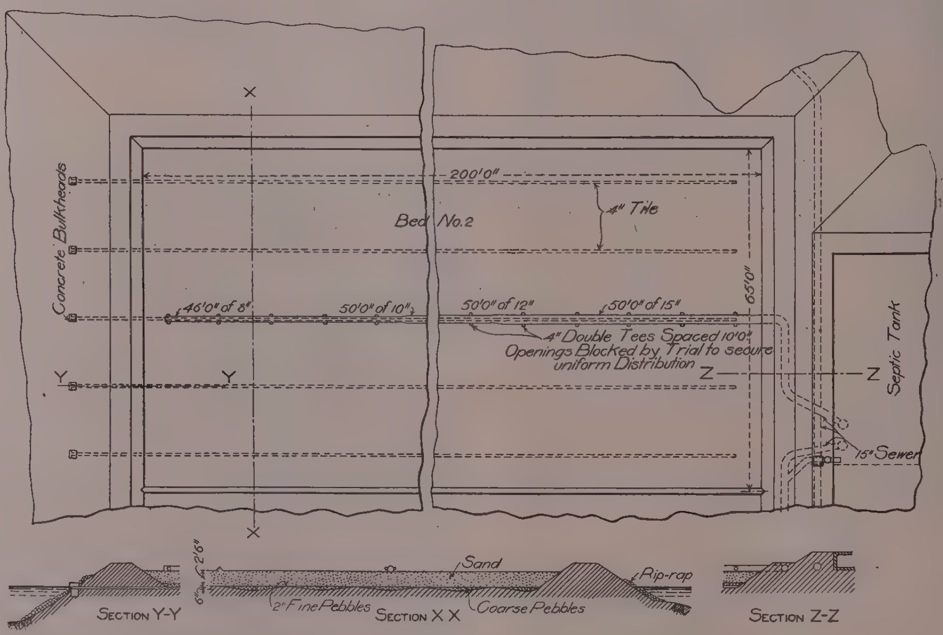
An accompanying illustration gives a view of the filter beds during construction. The northwest corner of filter No. 2 was built in 9 ft. of water. No special difficulty was encountered in the grading. The embankments have successfully stood the test of one winter's exposure to ice action.



Plan and Sections of Sewage Lift.



Plan and Sections of Septic Tank.



Part Plan and Sections of Sewage Filters.

The sewage disposal plant and the main sewer, from Webster St. to the outlet, were built in 1906, by the Turner Improvement Co., of Des Moines, Iowa. The sewer on Albion Ave. from Budd to Webster St. has been nearly completed during the past season, and bids are about to be opened for a considerable part of the remainder of the system.

The contract prices for the work done in 1906 were as follows: 18-in. sewer, complete, $1.80 per foot; 15-in. sewer, complete (6 to 24 ft. deep), $2.15 per foot; 10-in. sub-drains, complete, 30 cts. per foot; 8-in. sub-drains, complete, 25 cts. per foot; 6-in. sub-drains, complete, 20 cts. per foot; regular manholes, $50 each; combined flush tanks and manholes, $80 each; sewage disposal plant, complete except siphons and sand and gravel for filters, $3,998.50. The city furnished and placed the sand and gravel, about 2,650 cu. yd., at a cost of 90 cts. to 35 cts. per yard, besides the cost of screening the pebbles placed around the tile under-drains. The haul varied from 1½ to 4 miles. The city also placed the rip-rap, at a cost which was probably about $300, and furnished the alternating siphons at a cost of $150. Mr. D. R. Moore served as resident engineer during most of the work done in 1906.

The sewage disposal plant was put into operation in the spring of 1907. At first, considerable trouble was experienced from odor, on account of a large volume of creamery and butter refinery waste, which was passed through the filters with difficulty. This was cut off, and since then the plant has operated very successfully, with a discharge of about 24,000 gal. of sewage per day. At the time of a recent visit by the writer, it was practically free from odor, the beds were clean and took the sewage readily, and the effluent into the lake was as clear, sparkling and free from odor as well water. There was, however, complaint from one of the houses, located 200 ft. away, of objectionable odors from the plant, but with claim by the city authorities that such complaint was not justified.

Operating Time as an Element in Considering Grade Reductions.

The discussion of the report of the Committee on Economics of Railway Location at the last meeting of the American Railway Engineering and Maintenance of Way Association brought up the question of operating time as an element in considering grade reductions. The question is further discussed by Mr. A. K. Shurtleff in the November, 1907, "Bulletin" of the above association, from which the following abstract is taken.

The time required in passing over a given district is an element that should be considered in grade reduction in order to approximate the results that can be attained in actual operation. Competition, legislation and the schedules of pay for engine and trainmen fix the maximum time allowable in passing over the district. The actual running time is of necessity less than this total time. The density of traffic and distance between passing tracks materially affect the actual running time, particularly on a single-track road, as the question of meeting points as well as getting in the clear for passing superior trains enters into the question. The following table compiled from the train sheets of different operating districts, and covering fifteen days' time on each district, illustrates this point.

District G in the accompanying table illustrates the value of double track as a time saver, 77 per cent. of this district being double track.

District.	Trains. Each Way per Day.	Distance Between Passing Tracks, Miles.	Freight Trains Time Lost in Stops per Hour on Road, Min.	Remarks.
A	7	6.1	12	All single track.
B	7.5	4.5	11.5	" " "
C	8.5	5.2	12	8% double track.
D	10	5.2	15	13% " "
E	10	4.1	17	All single track.
F	12	4.6	21.5	13% double track.
G	12.5	4.4	8.5	77% " "
H	12.5	4.5	20.5	All single track.
I	12.5	4.3	21	" " "
J	13	4.7	17.5	" " "
K	14.5	4.6	26.5	" " "

It has been too frequently the custom to base the estimate of savings by a reduction of grade on the train mileage saving, estimating the tonnage that may be hauled at 10 miles per hour maintained speed on each of the gradients under consideration without considering the question of time. It is true that the same locomotive could take the heavier train over the lighter grade, but unless the total elevation to be overcome is not sufficiently reduced this heavier train will be handled at a greater expenditure of time. In case competition or economy does not permit the lengthening of the time over the district, the tonnage of the trains must be reduced, thus causing a loss of a portion of the benefits estimated. As a matter of fact, on any engine district where a locomotive must exert its maximum power at all points in order to get over the district in the required time, there will be little or no benefit derived in reducing the maximum gradient, providing the total elevation to be overcome is not reduced. This statement may be questioned by many engineers, but a careful study of the accompanying profile and methods of calculation should demonstrate the absolute correctness of the assertion. The profile is an assumed one, covering a 15-mile run from *C* to *E*. The maximum grade for the solid line is 0.5 per cent. and for dotted line 0.3 per cent. It is further assumed that either gradient can be obtained without lengthening the line.

The locomotive considered is a simple consolidation type, weighing 170 tons in working order and capable of exerting the drawbar pull on level grade at the various maintained speeds shown in following table:

Speed, M. P. H.	D. B. Pull, Lb.	Speed, M. P. H.	D. B. Pull, Lb.	Speed, M. P. H.	D. B. Pull, Lb.
Start......	39,364	12........	25,338	24........	11,462
1........	39,257	13........	23,242	25........	10,882
2........	39,148	14........	21,437	26........	10,341
3........	39,038	15........	19,868	27........	9,835
4........	38,928	16........	18,491	28........	9,361
5........	38,816	17........	17,272	29........	8,915
6........	38,703	18........	16,181	30........	8,495
7........	38,588	19........	15,200	31........	8,096
8........	35,896	20........	14,314	32........	7,719
9........	33,203	21........	13,507	33........	7,361
10........	30,508	22........	12,769	34........	7,020
11........	27,812	23........	12,088	35........	6,692

The maximum speed permitted for freight trains is assumed to be 35 miles per hour.

The train considered is composed of empties or light loads. Resistance on level grade as follows: Starting, 13 lb. per ton; 1 mile per hour, 9 lb. per ton; 2 miles per hour, 7 lb. per ton; 3 miles per hour and over, 6 lb. per ton.

Grade resistance in pounds per ton is equal to 20 times the rate per cent. of the gradient.

The resistance due to acceleration and the energy of retardation is equal to $70\,(V_1^2 - V_2^2) \div D$, in which V_2 and V_1 represent the initial and the terminal velocities in miles per hour, and D equals the distance in feet traveled in accelerating or retarding the velocity.

Train A is the maximum weight train that can be hauled on a 0.5 per cent. grade at 10 M.P.H. maintained speed. Weight of train behind engine, 1,800 tons; weight of engine and tender, 170 tons; total weight of train, 1,970 tons.

Train B is the maximum weight train that can be hauled on a 0.3 per cent. grade at 10 M.P.H. maintained speed. Weight of train behind engine, 2,457 tons; weight of engine and tender, 170 tons; total weight of train, 2,627 tons.

Having selected the locomotive with which to study the problem and determined the weight of train, the procedure consists in computing and arranging a series of tables from which the accompanying curves are plotted. From the table of drawbar pull given above, the mean drawbar pull on level grade between velocities of 0 and 35 miles per hour can be calculated for each difference in velocity of one mile per hour. By deducting from this the train resistance, which is constant at 6 lb. per ton at and above speeds of 3 miles per hour, the difference will show the number of pounds for accelerating or retarding the velocity of the train. For train A the mean drawbar pull at maintained speed becomes equal to the train resistance at 25.2 miles per hour, and is less than the train resistance for greater speeds. In the case of train B the drawbar pull is less than the train resistance above 19.5 miles per hour.

Where the drawbar pull is greater than the train resistance, the excess engine power would be used in accelerating the speed of the engine and train. Where there is a deficiency in power, the speed would be retarded. The difference in the two quantities per ton is obtained by dividing the total difference by the total weight of train, including engine. The difference per ton, therefore, represents the resistance of acceleration that can be overcome by the locomotive where it is positive, or the energy of retardation that can be realized where it is a negative quantity.

For other grades than a level grade, this difference per ton would be decreased 2 lb. per ton for each one-tenth per cent. change in gradient for ascending grades, or increased for descending grades.

The distances traveled in accelerating or retarding speeds from mile to mile, is obtained by transposing the equation for resistance due to acceleration.

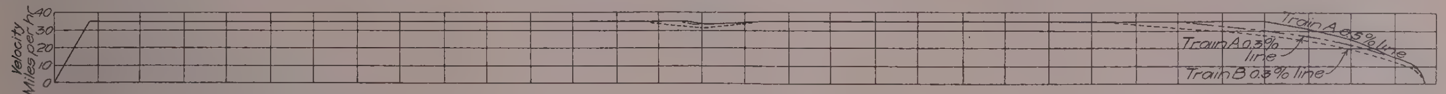
Feet distance traveled $= 70\,(V_1^2 - V_2^2) \div R$, where R equals the difference per ton between power of engine and resistance of train, as already explained. Whenever the difference per ton is positive, i. e., when the drawbar pull is in excess of train resistance, the distance traveled, obtained by the formula, will represent distances traveled in acceleration, while, when it is negative, the distances will be those in retardation of velocity.

With these tables prepared, the speed that can be attained with the engine exerting its maximum power can be determined at the various points on the profile, and other tables arranged showing these speeds, the average velocity, the distance traveled, and the time consumed. From such tables the accompanying curves were prepared. The performance is given for train A on both the 0.5 and 0.3 per cent. lines and for train B on the 0.3 per cent. line. The velocity and time are given in the accompanying table.

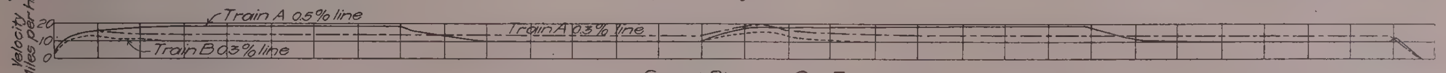
It will be noted that in descending there is practically no difference between the various trains and grades, but in ascending the hill the time for train A is the same on either the 0.5 per cent. or the 0.3 per cent., while the time for train B on the 0.3 per cent. is over 30 per cent. longer than time of train A.

	Ascending, *C* to *E*		Descending, *E* to *C*	
	Av. Velocity, M. P. H.	Total Time, Min.	Av. Velocity, M. P. H.	Total Time, Min.
Train A on 0.5% line.	13.2	68	31	29
Train A on 0.3% line.	13.2	68	30	30
Train B on 0.3% line.	10.1	89	28.7	31

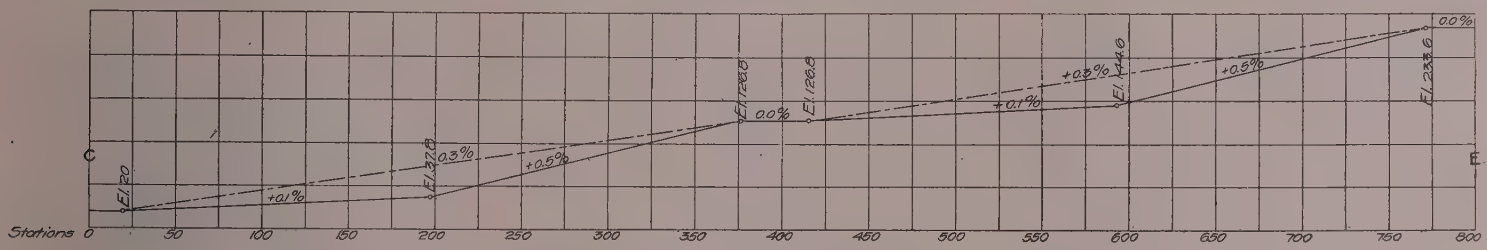
The reason for this difference in time becomes more apparent if we consider that a locomotive can develop a given drawbar horse-power at each speed, this horse-power increasing rapidly from the starting point to a maximum at a point slightly above the velocity where cut off must be shortened, and then decreasing gradually in a curve, as velocity increases. With the engine considered here, the shortening of cut-off takes place at a 7 miles per hour velocity and maximum cylinder horse-power as well as drawbar horse-power is obtained at about 11 miles' velocity. Drawbar horse-power is the product of drawbar pull times velocity in miles per hour divided by 375. The average drawbar horse-power would be obtained by using average drawbar pull and speed in this equation. The average drawbar pull per ton of train on any two profiles having the same elevation to overcome will be the same, providing the distance and conditions of weather, track and equipment are the same. Therefore with the locomotive working at its maximum, any increase in tonnage of train would necessitate a decrease in the average velocity of train. The principle demonstrated will hold good no matter what the two gradients that are under consid-



Speed Diagram E to C



Speed Diagram C to E



Profile of Line Fifteen Miles Long and Speed Diagrams for Travel in Both Directions.

eration may be, provided the engine can work at its maximum power without exceeding the assumed safe maximum velocity. It will also hold good if the loading of the trains on each of the controlling gradients be at any other practical speed than the 10 mile per hour velocity assumed in this discussion.

The amount of additional time required would vary, depending on the physical features. On drag districts, where the ascent is all in one direction and generally continuous over the district, the additional time required for the heavier train against the grade would be greater than on districts where the ascending and descending grades balanced.

For convenience and illustration two such districts of 120 miles each are assumed with 0.3 per cent. controlling gradients on each 15 miles. Trains are to stop each 15 miles for water or meeting points. The first district has 120 miles ascending grade. The second district has 60 miles of ascending grade and 60 miles descending. The actual running time over the districts would be as follows: For the district of all ascending grades the time of train A would be 9 hr. 4 min., for train B 11 hr. 52 min., a difference of 2 hr. 48 min. For the other district the time of train A would be 6 hr. 32 min., and for train B, 8 hr., a difference of 1 hr. 28 min.

This would represent the two extremes of the case under consideration. The cases where anticipated results have not been realized in practice are probably due to the fact that they are somewhat similar to the first case, with the great bulk of traffic moving against the grade, and this controlling grade covering the major portion of the district.

Assuming that the delay or time lost at stops averages 15 minutes for each of the seven intermediate stops, there would be 1¾ hours' additional time in getting over the district. Schedules of pay for trainmen generally specify that when the time of the train averages less than 10 miles per hour, overtime will be paid for. The above districts would require pay for overtime on all time in excess of 12 hours, with fractions of one-half hour or more counted as full hours. For every Train B passing over the 120 miles of ascending grade, there would be two hours' overtime to be paid for. Train A on the same district would have one hour to spare, but if competition should require that the schedule time be maintained at 11 hours, this train would have accomplished the work on the 0.5 per cent. controlling grade without the expenditure of any more fuel than is expended on the 0.3 per cent. line.

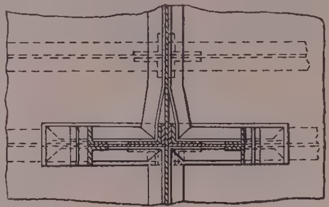
With these points in view, it would certainly seem advisable to work up a time diagram on the different grades and lines before authorizing the expenditure of large sums of money for the reduction of grades in order to determine the economical gradient. After tables have been prepared for each controlling gradient showing the distance traveled in accelerating and retarding speeds on the various grades, a few days' time only will be required to work up time diagrams on an average engine district, with a possibility of saving a large waste in money.

A Crane Rail Girder of reinforced concrete supported in a peculiar manner, has been built along the back of a massive concrete wall at the Newport, England, dock extension. The wall is 39 ft. high. A continuous girder runs parallel to and a short distance from the vertical back face of the wall, to which it is tied every 10 ft. by reinforced concrete ties. The girder and ties are at the elevation of the top of the wall. The support from below is provided by struts of reinforced concrete on 10 ft. centres, running diagonally from the girder to the stepped foundation of the wall.

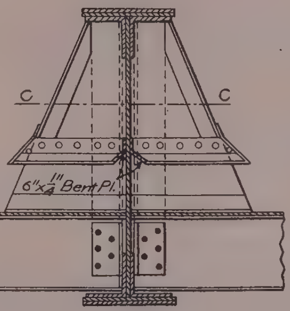
Erection and Waterproofing of Plate Girder Bridges at Plainfield, N. J.

During the past summer The Central Railroad Company of New Jersey has replaced seven of its old four-track bridges at Plainfield, N. J., with half-through plate girder bridges, designed for 187½-ton engines, and with solid ballasted floors. Two different types are used, depending on the requirements of the streets spanned by the bridges. Single-span four-track bridges are used at Leland Ave. and Washington St., three-span four-track bridges at Richmond St., Watchung, Park and Clinton Ave., and a three-span five-track bridge at Berckman St.

The bridges consisting of three spans have the center span across the street carried on rows of columns at the curb line, while shorter girders are used to span the sidewalk from the columns to the abutments. The floor system of the old bridges had a depth of 24 in., while the new ones have a floor depth ranging from 30½ to 34 in., the minimum depth of ballast beneath the bottom of tie being 6 in.



Section C-C.



Flashing Angle around Bracket.

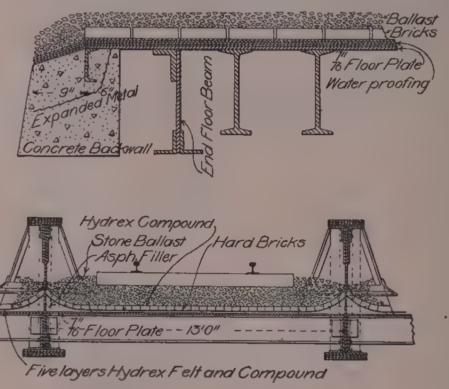
The length of the main girders over streets varies from 33 ft. to 34 ft. 5 in. center to center of columns for the three-span bridges. The main girders of the single span bridges are 56 ft. 6 in. over all at Leland Ave. and 38 ft. at Washington St.

The column footings, instead of being individual ones for each column, are carried across the full width of the bridge as a continuous pier and reinforced with old rails, lapped 3 ft. at the breaks. The column pedestals are of cast steel, anchored into the piers by bolts, which are held at the lower ends by 6 x 6 x ½-in. plates, with a nut on each side of them. The columns consist of double-laced fifteen-inch channels, with their flanges turned inward.

The floor beams spanning between the main girders, which are 13-ft. centers, are placed on approximately 18-in. centers and are composed of 12 and 15-in. I-beams, the beams being uniform in any one bridge, except that a heavier section is used at the stiffener brackets. The floor beams are carried across the sidewalks between shorter girders in the same fashion as over the street, and not as is sometimes done, by placing them parallel with the center line of track. A solid 7/16-in. floor plate is riveted in sections on the top of the I-beams, with ¾-in. rivets, and extends the full length of the bridge. A concrete backwall is carried above the bridge seat of the abutments to the level of the tops of the I-beams and in it is imbedded a small channel, with the outside of one of its flanges flush with the top of the backwall. The 7/16-in. floor plate continues over the backwall and terminates on this channel.

On this steel floor plate, in which all rivets are countersunk and chipped, are laid five layers of Hydrex felt and waterproofing compound, extending continuously the length of the bridge, and lapping over, beyond the ends of the steel floor plate, to the back faces of the abutments. A course of hard-burned shale brick covers these layers, the joints being filled with Hydrex compound, and as a final application, the top surface of the bricks themselves was thoroughly mopped with the compound.

The waterproofing is carried up onto the webs of the girders to a height of about 10½ in., at which elevation a flashing angle, consisting of a 6 x ¼-in. bent plate, is riveted to the webs of the girders and to the stiffener brackets. This flashing angle fits down over the waterproofing and prevents the water from working down alongside of the web and stiffener brackets and turns it onto the top of the waterproofed surface. While the application of this angle to the straight web of the girders is a simple matter, the problem becomes somewhat difficult when fitting around the stiffener brackets and angles. Special cast and forged plates are used at stiffener angles, while beveled fillers are used to close the space where the angle is bent out from the web to fit over the leg of the stiffener angles. At the corner formed by the steel floor plate and the web of the main girders, the waterproofing is raised by means of a triangular shaped filler of asphaltic concrete.



Method of Waterproofing.

No provision is made for weep holes for drainage of the accumulated water, all of it being carried away over the back faces of the abutments. In order to effect this drainage, all of the bridges which did not happen to be on a grade of 5 in. to 100 ft., or over, were given that minimum slope.

The removal of the old bridges and the substitution of the new ones, a total of twenty-nine tracks, was begun about April 1, 1907, and completed, in spite of a number of delays, by September 1, 1907. The erection of the bridges was carried on in groups of one, two or three bridges. Only one group was erected at any one time. The last group, consisting of the three bridges at Washington St., Watchung Ave. and Park Ave., a total of twelve tracks, was erected in 42 working days, including Sundays, an average of 3½ days to each track. During this period, it was necessary to remove the old ironwork and masonry column footings, construct new column footings, place and field-bolt or rivet the new steelwork in position, carry up a concrete backwall, waterproof the bridge and replace the tracks. Of the time required for each track, 3½ days, the waterproofing alone required 2 days. Previous to the erection of the bridges, the old abutments were cut down, grouted and the new bridge seat stones set.

During the erection of the steelwork, the railroad traffic was confined to two tracks. The two northerly tracks were abandoned first, and, as soon as the steelwork and waterproofing were completed for the northerly track, traffic was restored to it and the two center tracks abandoned. Subsequently, a second track was put in commission and the two southerly tracks abandoned. The erection of the bridge was then completed, the third track being put in commission a few days previous to restoring traffic on the entire bridge. After the abandonment of tracks, the old ironwork was immediately removed with a 100-ton wrecking crane, belonging to the railroad company. The new column footings were then constructed and the new steelwork set with the wrecking crane.

Crossovers were installed at each end of the groups of bridges to be renewed, and, while the renewals were in progress, these crossovers were interlocked and the signal system incorporated with the regular system, an operator and switchman being stationed at each set of crossovers.

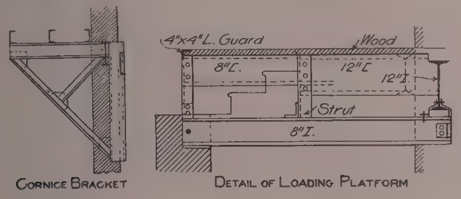
The removal of the old bridges and the changes to the masonry abutments and column footings were done by the railroad company. The steelwork was furnished and erected by The Pennsylvania Steel Co., with the exception of one bridge, which was furnished and erected by the Toledo-Massillon Bridge Co. The waterproofing was done by the Hydrex Felt & Engineering Co.

The bridges were designed in the bridge department of The Central Railroad Co. of New Jersey, Mr. A. L. Bowman, bridge engineer, under the direction of Mr. Jos. O. Osgood, chief engineer.

A HOUSE WITHOUT A CHIMNEY is a twentieth century novelty at Carrollton, Ill., a residence having recently been completed there that is fitted for steam heating from a central station plant, and with electrical cooking and auxiliary heating equipment, thus avoiding the use of stoves.

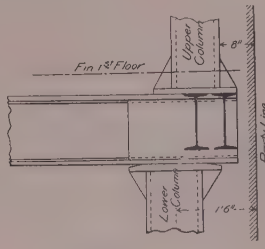
The Steel Warehouse of the Fruit Auction Company.

The first six stories of a 75 x 87½-ft. 10-story building have just been completed at Franklin and Washington Sts., New York, for the storage and salesrooms of the Fruit Auction Co. and for general office room and loft purposes. It has a framework of rectangular cast-iron columns and steel I-beams supporting the floors, roof and walls, and although of simple standard construction, contains a number of interesting features and special details.

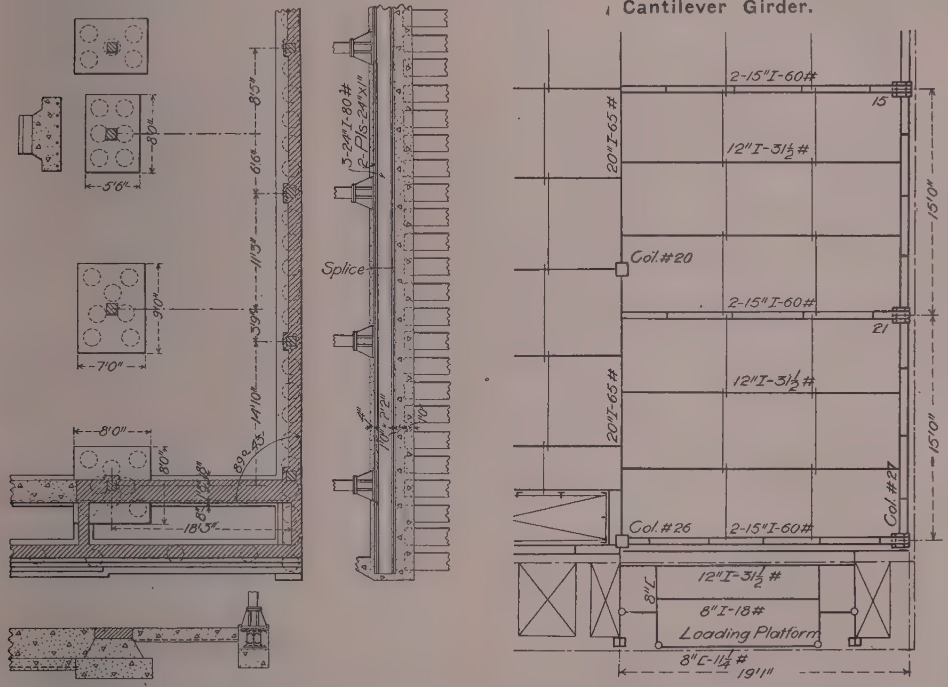


CORNICE BRACKET DETAIL OF LOADING PLATFORM

Cornice Bracket and Loading Platform.



Cantilever Girder.



Concrete Piles, Distributing Girders and Part Plan of First Tier, Fruit Auction Company's Warehouse.

All of the dead and live load of the building, except a small portion of the exterior walls, is concentrated in column loads of about 66 to 320 tons, carried on concrete footings resting on sand at about 10 ft. below street level. The footings are proportioned for a maximum load of about 8,000 lb. per square foot on the surface of the soil and are also provided with concrete pile foundations which theoretically are not called upon to carry any part of the load unless the soil proves inadequate to support the calculated pressure, and permits settlements which will distribute a part of the load through the piles.

The piles, of the Simplex type, are 30 in. in diameter, have an average length of about 20 ft., and have been very carefully arranged so that they are located in groups symmetrical with the centers of gravity of the loads and are thus expected to carry exactly their uniform proportional part of superimposed weight. The usual system of arranging them in longitudinal and transverse rows with constant spacing has been departed from and in piers having seven piles, three are arranged in the center at the apexes of a triangle whose center of gravity coincides with that of the column. The remaining four are located near the corners of the pier, equidistant from the column center. Similarly in eight column piers, the four interior columns are grouped equidistantly on the circumference of a circle concentric with the pier center and the exterior columns are placed as before at the corners, thus avoiding undue bending moment in the footing.

On two sides of the building adjacent to the party line the ordinary system of construction would have necessitated the support of wall columns on cantilever girders in order to avoid eccentric loadings of the foundation piers. This expense and the obstruction of the cellar by means of heavy transverse girders was obviated by supporting the columns on very long and narrow piers in the planes of the wall. The piers were continuous structures the full length of the building and were made with single rows of concrete piles spaced about 30 in. c. c. and receiving equal portions of the loads through distributing girders built into the thickness of the wall. These girders, really act as reversed cantilevers, and on account of the heavy shear which must necessarily be provided for, are shallow and massive, thus permitting the utilization of rolled sections. Each of them is made with three 24-in. 80-lb. I-beams, bolted together with cast-iron standard separators ground to exactly fit the webs, flanges, and fillets, and are provided with single 24 x 1-in. full-length top and bottom flange cover plates. The closed interior of the triple-web box girder thus formed, is not grouted, but the entire exterior surface of the girder is enclosed in a solid mass of concrete, insuring its permanent protection. The concrete footings of the interior columns are provided with the usual rectangular granite capstones on which the cast-iron column pedestals are seated with grouted beds.

Alternative designs for riveted steel and for cast-iron columns were submitted and the latter were adopted on account of greater economy in cost and rapidity of manufacture and delivery. There are 27 main columns of standard rectangular cross section with flange connections and bracket supports for the beams and girders. They have a uniform length of 11 ft. 4 in., in the second and upper stories and vary from a minimum of 6 x 6 x ¾-in. in the 10th story to a maximum of 12 x 12 x 1⅜ in. in the cellar. The maximum load of about 300 tons requires about 38 sq. in. cross sectional area for one of the columns supporting a 4th floor girder. The column data was calculated in special manner on a sheet which showed all of the principal requirements, conditions and special notes in such a manner that a designer familiar with the general character of the construction would be reminded by its inspection of every factor involved for each column.

The cross section of the wall at one end of the sheet gives its thicknesses and weight per square foot at different elevations and also gives the total column load derived from the dead and live weight of successive stories modified in accordance with the requirements of the building law. The successive loads from the top down were as follows: Per square foot, main roof, 120 lb., 10th floor, 125; 9th, 132; 8th, 128; 7th, 124; 6th, 120; 5th, 117; 4th, 113; 3rd, 109, for the regular floor, and 150 for the auditorium, 2nd, 105 for the regular floor and 150 for the auditorium, 1st, 210, for the regular floor and 380 for the sidewalk platform.

The most unusual structural feature is the introduction in a loft and office building of a large auditorium hall, with the ceiling nearly 20 ft. high, in the second and third stories. This is used for the auction room and is provided with rising tiers of seats overlooking the auctioneer's desk, adjacent to which are located a group of elevators from which the fruit, principally grapes, is brought from the basement and sold. In the middle of the Franklin St. side of this room there is, at the regular second floor level, a horizontal platform for the auctioneer. On the other three sides inclined tiers of seats reach up to one side wall and to an opposite row of interior columns, and the main tier of seats rises from the long side of the platform to a second horizontal platform about 15 ft. wide and 35 ft. long and 5 ft. above the 3rd floor level in the rear of the room. Entrance to the auditorium is provided by three sets of stairs, together covering most of the space in the line of the intermediate row of columns where the seats of one side terminate.

The construction is very simple and consists of 15-in. horizontal I-beams for the main transverse girders which support the 10-in. I-beams about 5 ft. apart and 20 ft. long, which are inclined nearly 30 deg. with the horizontal to carry the tiers of ascending seats. Column 17 is located near the center line of the fruit elevators and in order to eliminate it from the auction room, its upper stories are supported on a box plate girder in the fourth tier of beams. This girder is about 37 ft. long, 3½ ft. deep and 2½ in. wide over all and has two 42 x ½-in. full length continuous web plates bolted at the extremities across the outer faces of two of the main columns. The two 6 x 6 x ¾-in. angles in each flange are reinforced by two 30 x ¾-in. cover plates and the webs are divided into short panels by single 4 x 4 x ⅜-in. vertical stiffeners, which serve as connections for the I-beams in the floors. Near the center of the girder the webs are reinforced by eight 5 x 5 x ½-in. vertical stiffener angles which receive the shear from the column supported by the top flange at that point with a maximum load of about 146 tons. The girder was shipped to the site with the flange cover plates loose so that the two webs could be hoisted separately and assembled to the columns, after which the cover plates were riveted in position.

As it was necessary to set the basement columns 18 in. from the building line on the party wall sides in order to provide a central bearing on the distributing girders in the plane of the wall as already described, it was necessary to provide some method of offsetting the upper stories of columns to their required location, 8 in. in the clear from the building line. This was very simply and economically accomplished by using pairs of 15-in. I-beams for the main first floor girders; supporting them on the column caps, and continuing them 16 in. beyond the column centers, thus forming cantilevers which receive the first floor columns about 5 in. outside of the centers of the basement columns. The 15-in. I-beams are thus interposed between the tops of the lower columns and the bases of the upper columns and virtually form a short section of the column system and have their webs reinforced by ½-in. plates stiffening them for the heavy shears at the extremity.

Exterior loading platforms on both streets are built up about 18 in. above the sidewalk level with an angle framework and 8-in. transverse beams covered with a solid wooden deck and supported by the sidewalk beams resting at their outer ends on the retaining wall and at their inner ends suspended as indicated in the detail by plates web and flange riveted to the beams, bent to engage the lower flange of one of the wall girder beams and field riveted together through its web, as indicated in the detail.

As it was necessary in the basement to provide an unobstructed passageway under the elevator shaft, the pit for the latter terminates with a steel plate floor suspended from the first floor beams. Another deviation from the regularity of the standard construction was necessary in the framing around the stairway and elevator shaft where the landings come midway between the floors and the light horizontal beams are carried midway between the wall columns by a vertical strut composed of a single 12-in. 40-lb. I-beam.

The 4th and succeeding tiers consist chiefly of 15 and 18-in. transverse I-beam girders about 17 and 19 ft. long with 10-in. longitudinal beams about 5 ft. apart. The exterior brick walls are carried on 10 and 12-in. I-beams bracketed out from the floor girder I-beams which are centrally connected to the columns. The roof tier corresponds to the floors except that the beams are somewhat lighter and that provision is made for a heavy terra cotta cornice on the two street fronts of the building. Riveted brackets with a 4-ft. overhang as shown in the detail are secured to the tops of cast-iron wall columns and carry three lines of 6-in. 8-lb. channels with 16 to 19-ft. spans from which the terra cotta blocks are suspended. The floors and roof are of hollow tile flat arch construction, built by the National Fire-Proofing Co., and the walls are of brick with terra cotta trimmings.

Mr. Frank T. Cornell is the architect, Mr. Arthur E. Roberts, engineer of foundations and steel work, the William Young Co., general contractors, and the Foundation Co., contractor for foundations.

The Freezing of Wells and Pumps.

The freezing of wells and pumps causes much trouble throughout the Northern States during the winter. Strangely enough, the shallow, open wells give less trouble than the deeper, drilled or double-tubed driven wells, in which the inner or pump tube is carried below the outer casing. The determination of the cause of the freezing and of means for its prevention is of so great practical importance that a study of the subject has been made by the United States Geological Survey, which has recently issued the following notes concerning it. The freezing of wells is practically confined to districts where the air temperatures frequently go considerably below zero and where the materials penetrated are either porous or contain actual openings and passages through which the air can circulate. A study of the phenomena as a whole shows that they are closely connected with barometric changes. The direct cause of the freezing seems to be an indraft of cold air at periods of high barometer. Change of weather, reversing the direction of the air current, produces thaw. In open wells, where air obtains access through the soil and at the junction of curb and cover, a cement cover should be tightly fitted to the curb, and the curb itself should be coated with cement for some distance below the surface. In drilled or double-tubed driven wells the current of cold air drawn in at periods of high barometer between the outer and inner casing near the surface and passing out in a porous bed at the bottom above the water level will cause freezing if the water is pumped so that it stands in the inner tube above the lower end of the outer casing; and a long-continued current of such cold air may cause freezing of the ground water about and in the well tube. For this condition it is suggested that the space between the outer and inner tube near the surface be packed with some impervious material. A filling of cement resting on an improvised plug is probably the most effective. The home-made rag packing sometimes used is too porous to serve the purpose. The same treatment is suggested for wells with leaky casings, for driven wells passing through rocks porous enough to permit the passage of large currents of chilled air during periods of high barometer, and for wells in which the outer casing ends in some cavern or open passage; that is, the space between the well tube and the pump tube near the surface should be tightly plugged with impervious material.

A Septic Tank at Ithaca, New York.

At present the sewage of Ithaca, N. Y., is discharged into Cayuga Lake without treatment. It is delivered from the collecting system to a pumping station, placed at the edge of the city, from which it is pumped about three-quarters of a mile to the lake, through a 14-in. cast-iron outfall sewer, which terminates in a 14-in. wooden pipe extending 7,000 ft. into the lake. Pumping the sewage through such a long outfall, the capacity of which was insufficient, was not economical, and to lessen the cost of handling the sewage and at the same time to purify it somewhat, a septic tank and a new outfall have been built. The septic tank is placed near the pumping station and receives the discharge of the pumps; the effluent of the septic tank will be led into an 18-in. gravity outfall sewer only about 1,300 ft. long, terminating in Cayuga Inlet, as indicated on the accompanying general plan.

The septic tank is of reinforced concrete, 117 ft. long, 88 ft. wide and 14 ft. deep. It is divided into five compartments, each 16 ft. 9½ in. wide and 117 ft. long, by four vertical longitudinal walls, each 12 in. thick. Leaving the pumping station the sewage passes first into a small concrete grit chamber, about 3 ft. wide, 7½ ft. long and 14 ft. deep, the floor of which is at El. 0.0. The sewage is carried into this chamber through a 14-in. cast iron pipe which passes through the floor and rising vertically terminates at El. 8.5 with an open end. From the grit chamber the sewage flows into a covered concrete channel 3 ft. wide which extends across one end of the tank and is supported by concrete brackets 8 ft. 10¾ in. on centers, as shown in an accompanying illustration.

Each compartment of the tank is fed from this channel through two 6-in. vitrified pipes each of which is provided with a flap valve inside the channel and discharges through the horizontal stem of a tee branch placed at about the middle depth of the tank, as shown in the drawings. Each compartment is crossed about 10 ft. from the inlet end by a vertical transverse baffle wall, 9 in. thick and 7 ft. high, with three 12 x 24-in. openings in it just above the tank floor in each compartment. An exactly similar baffle wall is placed in each compartment about 10 ft. from the outlet end. Under normal conditions the estimated period of detention in the septic tank will be about 8 hr. The water surface is at El. 12 and the general elevation of the floor is 0.0.

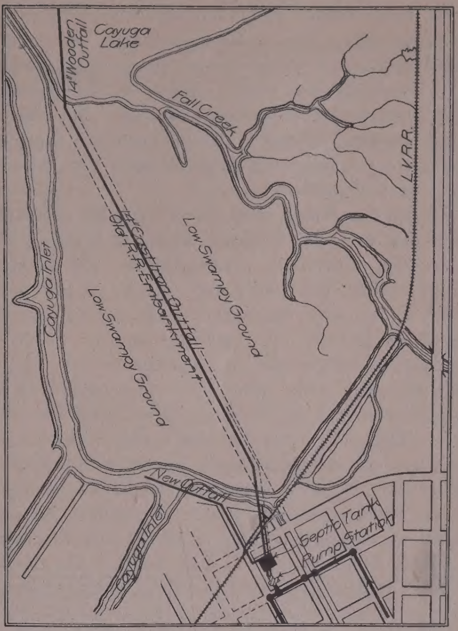
The effluent passes from each compartment through two 12 x 24-in. openings, the bottoms of which are about 2 ft. below the water level. These openings communicate directly with an open concrete channel, 4 ft. wide and 4½ ft. deep, carried across the end of the tank on concrete brackets like those which support the inlet channel. A longitudinal vertical division wall, 3 ft. high and 6 in. thick is placed on the center line of the channel; this is equipped with a ½ x 4-in. steel weir plate which runs the full width of the tank and over which the effluent flows, falling into the other half of the channel, which is equipped at one end with a short cross weir, the crest of which is 14½ in. below that of the long weir. Flowing over this weir the effluent passes into the 18-in. outfall pipe before mentioned and is led to Cayuga Inlet.

The floor of each compartment has a transverse slope at the rate of 2 ft. in 100 ft. and also slopes from each end toward the center at the rate of 1 ft. in 100 ft. A 10-in. terra cotta drain is laid under the tank approximately beneath its shorter axis, and each compartment has an 8-in. inlet into this drain. A concrete sludge well 12 ft. deep and 8 ft. in inside diameter is placed near the tank to receive the sludge that may be flushed out through the pipe drains. An 8-in.

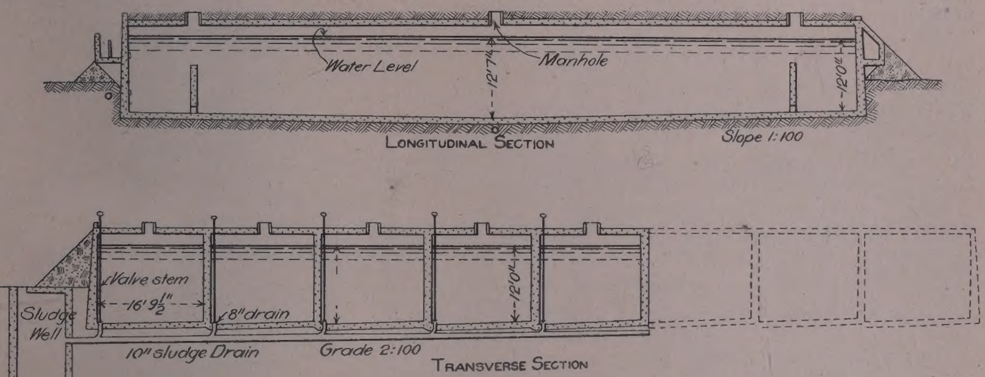
suction pipe leads from the well to a sludge pump.

The outfall sewer is made of terra cotta pipe except about 260 ft. near the septic tank, which is cast-iron pipe, which formerly served as an overflow in connection with the old system and was removed in excavating for the tank. Connected to the terra cotta pipe and extending into the Inlet, is 400 ft. of 18-in. wooden pipe. The Inlet is very shallow where the pipe line enters, and it was necessary to dredge a channel in which to lay the wooden extension. The pipe is built of hemlock staves banded with ¾-in. round iron hoops spaced 2 ft. apart. In each end of every stave is cut a 2-in. saw kerf. When the pipe was built sheet-steel splines were inserted in these kerps and made the staves practically continuous.

A platform was built at the end of the terra cotta pipe line a few inches above the surface of the water and the wooden pipe was assembled on this platform. As soon as a short section of pipe had been completed, it was pushed forward so that one end rested on the edge of the platform and the rest of the pipe floated on the water over the dredged channel before mentioned. The work was then carried forward by successively adding new sections assembled on the platform and attached to the rear end of the completed pipe, which was pushed forward, floating on the water as its length increased. When the entire 400 ft. had been built, the pipe was weighted with old street railway rails, wired on, and sunk to its proper position.



Plan Showing Location of Disposal Plant, Ithaca, N. Y.

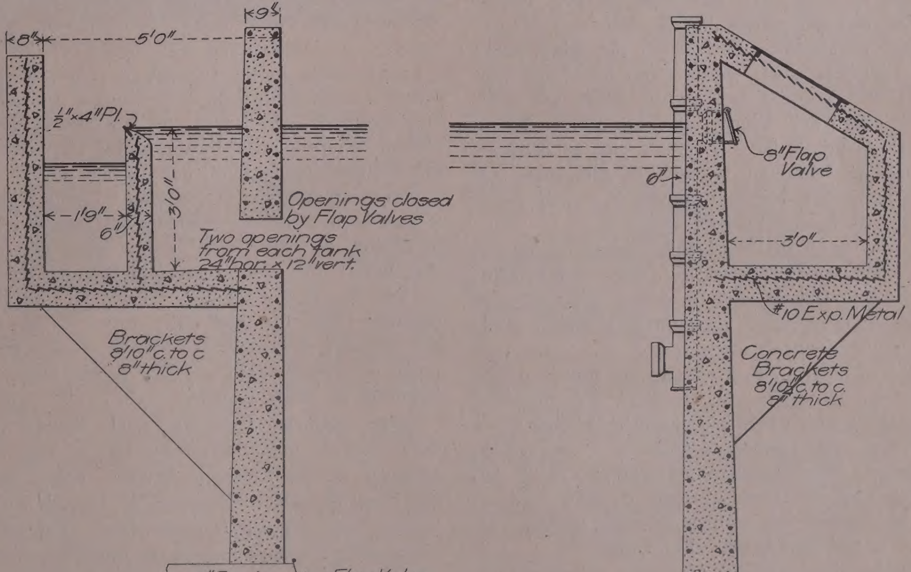


Sections of Ithaca Septic Tank.

The excavation for the tank was made with drag scraper down to within a few inches of the final grade to which it was continued with shovels. The top 3 ft. of excavated material was garbage and ashes which was underlaid by tough blue clay. A 3-in. centrifugal pump was run intermittently to keep down the water, the sludge well, which had already been built, serving as a sump.

The concrete used in all parts of the tank is a 1:2½:5 mixture of Portland cement, sand and screened bank gravel. A ½-yd. Ransome mixer was used in preparing the concrete for the 15-in. floor slab. A 10-in. layer of concrete was first put down; as soon as this had set, the reinforcing bars, which were required to be placed 1½ in. below the surface of the slab, were laid in place, wired together, and blocked up to the proper elevation; the rest of the concrete was then deposited and a finishing coat of one part of cement and three parts of sand was put on before the body of the concrete had set.

The six longitudinal walls were built next. These are 12 in. thick and 14 ft. high, and each is reinforced near each face with a double series of vertical and transverse ½-in. Ransome bars, the former being spaced 6 in. on centers and the latter 2 ft. on centers. These rods are extended into the end walls to form a bond at each intersection. The forms for one side of the longitudinal walls were built of 1-in. hemlock boards 8 ft. long, nailed to 2 x 5-in. vertical studding, 15 ft. long and spaced 2 ft. on centers. These sections were thus about 8 x 15 ft., and could be handled conveniently and used as many times as was necessary. The forms for the other side of each wall were built in sections 12 ft. long and 5 ft. high, so that the walls could be built up in 5-ft. sections; this facilitated the building of the somewhat thin walls with their double sets of reinforcing bars. One-half-in. round bolts were used to tie the forms together, and the vertical reinforcing bars were held in place by wooden templates, the horizontal bars being wired to the vertical ones in the usual manner. As soon as a 5-ft. section of wall had been built an additional set of forms was added and the wall was thus carried up almost continuously. The wall concrete was mixed by hand, the mixture being quite wet and the concrete puddled in the forms.


8"
5'0"
9"
½"x4"Pl.
1'9"
6"
3'0"
Openings closed by Flap Valves
Two openings from each tank 24" hor. x 12" vert.
Brackets 8'10" c. to c 8" thick
6" Drain
Flap Valve
15"
15"
8" Flap Valve
6"
3'0"
#10 Exp. Metal
Concrete Brackets 8'10" c. to c. 8" thick
15"

Sections of Inlet and Outlet Ends of Septic Tank.

The reinforcement in the end walls is substantially the same as in the longitudinal walls. The end walls were carried up to the level of the top surface of the lateral channel floor slabs and the latter were then built, the supporting brackets having been carried up with the walls. The tank walls were then extended up to their full height and the walls of the channels were built later. Expanded metal with a 3-in. mesh is used for reinforcement in the floor and walls of the channels.

Extending transversely across the tank, through the longitudinal walls 1 ft. below the top of these walls are 1-in. tie rods spaced 5 ft. on centers to give the walls additional supports when the compartments are full of sewage. When the tank is empty the outside walls become retaining walls, and to afford additional support against this pressure there are three lines of transverse I-beam struts extending clear across the tank.

Care was taken to secure a dense concrete throughout the work, and the only waterproofing treatment given the walls was a wash of cement grout.

The plans for the work described were prepared by Mr. H. N. Ogden, consulting engineer, Ithaca, N. Y., and professor of municipal and sanitary engineering in Cornell University, who supplied the data from which the foregoing notes have been prepared. Mr. B. G. Coon, Kingston, Pa., whose bid for the work, including the supplying and laying the outfall pipe, was $17,900, was the contractor.

The Relation of Waterways to Drainage Areas.

A paper read at the Annual Meeting of the Illinois Society of Engineers and Surveyors, by M. L. Enger.

In general, the size of a waterway depends upon the size of the drainage area, the length of time required for the water to concentrate from the most remote parts of the drainage area, the maximum rainfall for this length of time, and the amount of run-off. The amount of run-off depends upon the amount of evaporation, percolation and pondage. For small drainage areas evaporation is negligible. Percolation may be quite closely estimated from the character of the ground, while pondage, though an important factor in many cases, is hard to estimate, even approximately. Pondage also affects the time required for water to concentrate from the most remote parts of the drainage area.

The following notes refer particularly to conditions in Minnesota and the Dakotas. To understand the topography of these States a knowledge of its glacial history is necessary. The southern border of the glaciers, which once swept the northern part of the continent, is easily traced. Eastward from the Rocky Mountains it crossed Montana, the western part of North Dakota, the heart of South Dakota, western Nebraska and Kansas, middle Missouri, southern Illinois and Indiana, northern Kentucky, southern Ohio, Pennsylvania, New York and New Jersey and into the Atlantic. Nowhere in all the ice-covered area of the continent are the traces of glacial work clearer than in Minnesota, and nowhere does its presence exert a greater influence on topography. Professor C. W. Hall estimates that the total average thickness of glacial drift for the entire State must be about 100 ft.

One of the most noticeable features of Minnesota topography is its great number of lakes. There are nearly 8,000 of them; almost all of glacial origin. The waters of some lie in depressions due to unequal distribution of drift material, others rest in hollows in the hard rock, left where the softer rock was worn away by glacial action, and yet others by the damming of preglacial waterways. Besides all the lakes, there are countless small depressions, from one foot to several hundred feet across, which are ordinarily dry, but which impound water during rains. South Dakota is not as rich in lakes as Minnesota, although remains of old lakes are very numerous, but its drainage is greatly interfered with by small depressions.

In dry years the depressions would escape notice. The last few years have been wet in Minnesota and Dakota, and the water is standing in ponds of every size. Even in quite rough country, the drainage is often very poor. An examination of twenty culverts along one branch of the Chicago, Milwaukee & St. Paul Ry. disclosed only three which ever had any flow through them, the rest were merely equalizers. One section foreman, after fifteen years' service, could tell which way water ran through only one culvert on his section. A number of other sections almost as bad as this one were found.

There are a number of formulas for estimating the size of waterway required for a given drainage area. Those of Meyer and Talbot are well known. They are, $a = c\sqrt{A}$ and $a = c\sqrt[4]{A^3}$ respectively, where a is the waterway required in square feet, A the drainage area in acres, and c a constant depending upon various conditions. A formula is valuable only as a guide to judgment, and as a means of comparing and classifying experience.

The Missouri, Kansas & Texas Ry. uses Talbot's formula, giving c average values of 0.65, 1.0 and 1.5 for flat, moderate and steep land respectively. For Minnesota and Dakota drainages, these values are much too large. From a study of about three hundred drainages, the writer concludes that c should be about 0.2, 0.4 and 0.6 for the respective cases. There is, of course, wide variation from these values. For the larger drainage areas, Meyer's formula seems to express the law of increase of required waterway better than does Talbot's.

As an example, Oak Creek, a little stream emptying into the Missouri River in South Dakota, has a drainage area of about 180 square miles, above the point the St. Paul Railway crosses it. The highwater cross-sectional area is about 320 sq. ft. between banks. Several bridges of about 160 sq. ft. cross section were washed away after standing twelve years. An eye-witness says an ice jam carried away one of the bridges. It seems that this bridge was almost large enough, as according to a resident, the highwater referred to was the greatest in the twenty-seven years of his residence. Assuming 300 sq. ft. of waterway necessary, c in Meyer's formula becomes about 0.9, and in Talbot's formula about 0.05. The drainage area consists of rolling, grass-covered land. The low discharge is mainly due to the little depressions, which impound water during rains, and in which the water stands until it is gradually evaporated or absorbed by the ground.

Much can be learned from a study of the channel a stream makes for itself. But in this one must be careful to give other conditions proper consideration. The character of the rock through which the ravine is cut, whether it is soft or hard, should be noted. The writer has in mind an 8 x 3-ft. culvert in the Root River valley, carrying successfully the drainage from 600 acres of very steep land. The ravine through which the discharge comes is about 150 ft. deep at the outlet. The cause for the small discharge is rapid absorption by the sandy soil. An area of similar size and shape, draining into the Mississippi River, 35 miles below St. Paul, requires an opening of about 120 sq. ft. There is an important difference in the two cases, however, the channel in the first case having a sand bottom, and the other a bed covered with large stones.

Large stones in the channel of a stream may create a false impression as to the size of waterway required. The writer recalls a case in South Dakota where a little draw draining 180 acres of moderately sloping land, had its bed filled with boulders up to 2 ft. in diameter. Upon inquiry it was learned that the boulders had been washed in during the "cloudburst" a few years ago, and that before this time, there had been practically no boulders in the channel. It can be said with certainty that the highwater referred to, was the greatest for several hundred years, and it seems improbable that one like it will occur for hundreds of years to come.

Large drainage areas in prairie country are very hard to obtain correctly, but in this case accuracy is not necessary, because, unless there is a draw to collect the water, the run-off is very small. This refers to very flat land. The writer measured a drainage area in the Red River valley of a 2 x 2-ft. culvert. The land in this vicinity was exceedingly flat. The culvert was located in a draw about 100 ft. wide, and 4 ft. below prairie level at its deepest point. The channel had been formed at times when the Wild Rice River had overflowed its banks and run cross country five miles to the Red River. The last overflow occurred between fifteen and twenty years ago. Except for a washout at that time, there has never been much water flowing through the culvert.

The thing desired is an opening large enough to carry the maximum discharge, and no larger. If highwater records over a long term of years are available, a drainage survey is not necessary. An old settler can usually give information more valuable in the choice of waterway than the most careful survey of the drainage area. It must be remembered, however, that a farmer living on the upstream side of a culvert will often differ with his neighbor on the downstream side as to the adequacy of the opening. In one instance, a farmer said a certain culvert was too small, as it backed water over his land. His neighbor on the other side of the track said he thought the culvert large enough to handle the highest water. The fact was that the culvert was large enough, but had been placed so low that there was always a little water standing in it. During the winter the culvert gradually froze full of ice, and of course backed water over the farmer's land when the snow melted.

The Centrifugal Pumping Plant at New Albany, Ind.

The New Albany Water Co. has completed and has had in operation for the past two months a new pumping station for supplying water to its reservoirs, which are located on the hills to the west of the city. The design of this station was quite an engineering proposition because the water is taken from the Ohio River, which has a variation in water level during a year's time of nearly 70 ft. The pumping house is situated on the river bank in the western portion of the city, and in order to get as near as possible to the lowest water level, a concrete shaft 70 ft. deep had to be built. At the bottom of this a four-stage vertical turbine pump is installed, which is direct connected to a Stanley, 250-h.-p. 2,000 volt, 60-cycle motor with a speed of 720 r. p. m., on the floor above, by means of a solid shaft in four sections 3 15/16 in. in diameter. The motor is run independently, so far as the vertical motion is concerned, by means of a flexible bearing. The shaft is supported laterally by a steady bearing at each landing, 10 ft. apart, and vertically by a hydraulic bearing operated by the pressure from the service main at 90 lb. when first started, but after the pump runs up to speed the shaft and runners are self-supported.

The intake pipe of the pump is a 24-in. cast-iron pipe which runs approximately 80 ft. from the pump house to a well in the river, built below the low-water mark, thus furnishing fresh supply of water at all times.

The discharge main to the reservoirs, which is nearly a mile in length, is of 20-in. cast-iron pipe reinforced with concrete at all angles in order to insure safety, as the minimum pressure is 120 lb. The water from the discharge main at the reservoirs passes through a weir, thus affording a means by which the amount of delivery can be taken at any time. From there the water has to pass through four settling basins with a total reserve capacity of 27,000,000 gal. before it is discharged into the service main.

Power to operate the motor is delivered from the central power station of the United Gas & Electric Co., about three-fourths of a mile distant.

The pump was built to deliver 2,600,000 gal. per day, and maintains an efficiency of 70 per cent. (at pump coupling). In a recent test made the following average readings were recorded: Speed, 685 r. p. m.; pressure, 120 lb.; vacuum, 11.75 in.; discharge, 2,404 gal. per minute; voltage, 4,000; amperage, 372. At this time the motor was developing 245 h.-p. against a head of 290 ft. (head varies from 240 to 295 ft.) and the pump was delivering at the rate of 3,460,000 gal. per day or a third more than its rated capacity. Several tests have been made since to check the preceding one, and also to see whether the pump was holding its efficiency and delivery, which in every case have been satisfactory.

Letters to the Editor.

TALL CHIMNEYS.

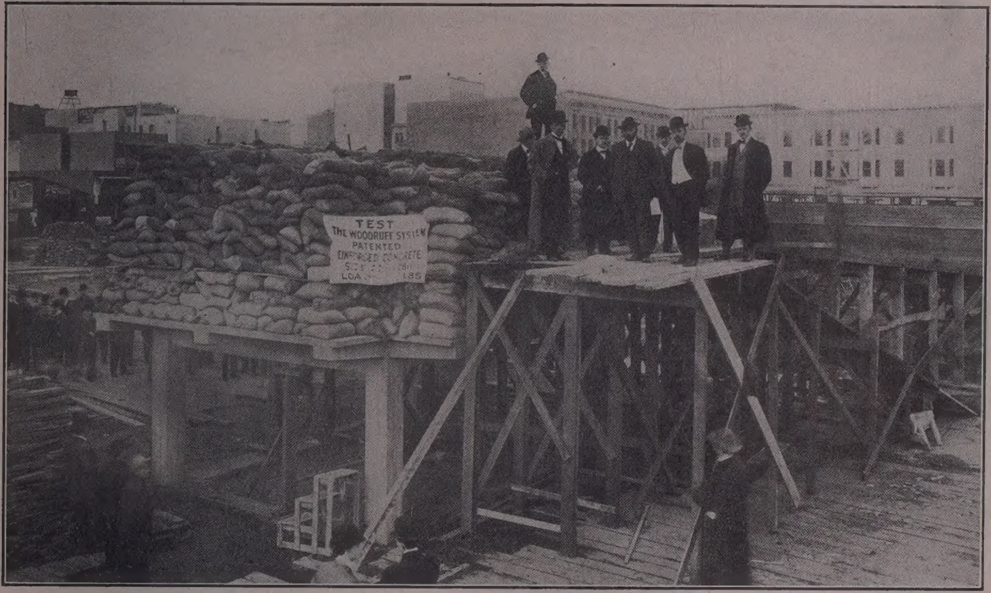
SIR: In the issue of your paper under date of Jan. 4th, you describe a tall brick chimney with acid-proof lining, and state that this chimney is the tallest in the world. We therefore wish to state that the highest chimney in the world and the most conspicuous building of this kind was erected by our firm about 20 years ago in Germany, but still holds the record of 460 ft.

New York, Jan. 18. H. R. HEINICKE, INC.

REINFORCED CONCRETE CHIMNEYS.

SIR: The article in The Engineering Record of Dec. 28 on this subject does not mention the most important cause of weakness of concrete chimneys as heretofore built, namely, the unavoidable loosening effect in the concrete by the shrinkage stresses in the upper portion at all times, and in the lower portion when under wind pressure. The new mode of construction invented and tested by the undersigned does entirely away with this evidently most dangerous defect and at the same time saves in cost of construction, especially in the necessary amount of steel reinforcement. The distinguishing feature of this system is in the steel rods, with initial strain imparted to them while the concrete is setting.

Very respectfully, CHARLES R. STEINER.
Gridley, Calif., Jan. 16.



Reinforced Concrete Floor Panel Recently Tested at San Francisco.

INSTRUCTION IN HEATING AND VENTILATION.

SIR: In your issue of Jan. 4 you publish a letter from Professor Kent, of Syracuse University, in which he takes exception to some statements in my letter which you published on Dec. 7. Professor Kent is inclined to disagree with me, but the disagreement is one of words and not of ideas; in fact, Professor Kent and I are in entire accord. He has simply misunderstood my statement, and rereading should bring out the differences between my proposal and the sort of instruction he mentions and which every good school includes in its curriculum. The real question at issue is: First, does the professional practice and business of heating and ventilating require more special-trained men than a full, modern, general course in mechanical engineering can turn out, and, secondly, if those engaged in this line should agree that there is a demand, what is the best way for the schools to meet the demand? My proposal is largely concerned with the latter phase of the question.

Yours very truly, CHARLES E. LUCKE.
Columbia Univ., Jan. 22.

A REINFORCED CONCRETE TEST PANEL.

SIR: Previous to the great earthquake and conflagration of 1906, which began on the morning of April 18, San Francisco possessed very little reinforced concrete construction. Some of the buildings in the city contained reinforced concrete floors which were suitably supported in such a manner as to demonstrate its possibilities should reinforced concrete be incorporated into a complete structure. Conclusions in this direction were confirmed by the good behavior of more complete structures in several of the towns contiguous to San Francisco. Naturally, considerable interest has been shown in the development and installation of reinforced concrete in the rehabilitation of the city, since it stood the test of quake and fire in such a satisfactory manner. Many specialists, therefore, branched off in this work, and in consequence to-day numerous reinforced concrete buildings are in evidence; some of which are worthy of the name, while others should be differently classified.

The city building ordinance prescribed the allowable stresses to be used in designing reinforced concrete work, but no extensive tests had been taken to substantiate the law and while it was considered to have been framed by mature, conservative judgment and experience, a test to demonstrate fully the behavior of a floor panel under load was undertaken by the Woodruff Company, incidentally demonstrating the efficiency of their own system. Accordingly, a typical floor panel was constructed on four columns and allowed to set for a period of 5½ months, until the approach of the rainy season made it desirable to carry out the test.

The panel represented a typical floor section, with four columns located in plan, on a 20 x 14-ft. rectangle, and supporting the floor at a height of 9 ft. above ground level. The footings were 3 ft. square by 1 ft. deep connected by horizontal struts 1 ft. square in both directions, the struts being reinforced with four ¾-in. rods bent to a 3-in. return at the ends. The footing reinforcement consisted of ten ¾-in. rods placed in two sets of five rods each. The columns were 14 x 14-in. reinforced with six ¾-in. rods, forming a square 4 in. from face of columns. Two of the bars were placed as intermediates on the two exterior faces of the column to provide for the bending tendency due to eccentric loading. Hoops 3-in. on center, of 5/16-in. rods were used.

The floor panel was framed with the girders on the short span supporting a beam at the center point. Both girders and beams were cantilevered a distance of 4 ft. beyond the column centers to bring into play to some extent the continuity action usually conceded to exist in floor design. Slabs, beams and girders were figured with *W L*/10 formulae, incorporating a 24-in. tee section in the computation. The concrete was taken at 600-lb. per square inch, with the steel at 16,000 lb. per square inch. The live load was assumed at 125 lb. square foot with *W L*/8, equivalent to 163 lb. square foot for *W L*/10. On the slab span of 7 ft. center to center of beams, ⅜-in. rods 3¼ in. center to center were required and were bent up to the top of the 4-in. slab over the supports. Three ⅜-in. distributing bars in each span were aids in the distribution of the load on the cantilever part of the platform. The beam reinforcement included four 1-in. rods placed in two vertical planes, with rods in contact in the respective planes; the two uppermost being bent upward near the columns and extended over the supports to within 2 in. of the end, returning along the bottom of the 4-ft. cantilever. The two lower rods had bent ends and were 2 in. from the bottom of the beam. Twenty-four 5/16-in. stirrups placed 2 to 16 in. on centers were used. The depth from the top of the slab to the bottom of the beam was 1 ft. 9 in. and the width was 6 in. at the bottom and 12 in. at the intersection with slab, forming a taper-sided beam. The girders were 1 ft. 10 in. deep tapering from 14 in. at the slab intersection to 8 in. at the bottom. They contained four 1-in. rods arranged in two vertical planes with an extension over the supports as in the beams. Twenty 5/16-in. stirrups, spaced 7 in. on centers were used.

The test was made on Dec. 7. Four thousand bags of sand weighing 100 lb. each had been prepared for loading. A force of fifty men wheeled the bags one bag at a time from the store-house up an incline to the top of the panel. No sign of distress was noticeable until a load of about 300 lb. per square foot had been imposed, when slight cracks in the bottom of the beams became visible. These opened slightly as the load was increased to about 500 lb., when diagonal tension shear lines appeared. At this load openings in the slab at the supports were also noticed. The loading was then continued until 710 lb. per square foot had been placed, when the bags of sand were all in place, forming a pile 12 ft. high. Nothing new developed at this loading except that the diagonal tension lines increased somewhat in number as well as in width. The most dangerous diagonal line appeared in one of the outside beams near the quarter point. A longitudinal vertical shear line was also apparent in this beam on about the plane of one set of bars. The maximum beam deflection at the center read 5/32 in.

The loading was discontinued at 710 lb. per square foot and the structure permitted to stand under this load for several days. No radical changes or deformations were noticed, the structure apparently sustaining the load safely.

The test was conducted by the Engineering Department of the Woodruff Company, Mr. R. V. Woods, chief engineer, with Prof. C. B. Wing, of Stanford University, and Prof. Charles Derleth, of the University of California, as associate engineers.

Very truly, HECTOR BURROUGHS.
San Francisco, Jan. 14.

The following notes on this test have also been received from the Woodruff Company:

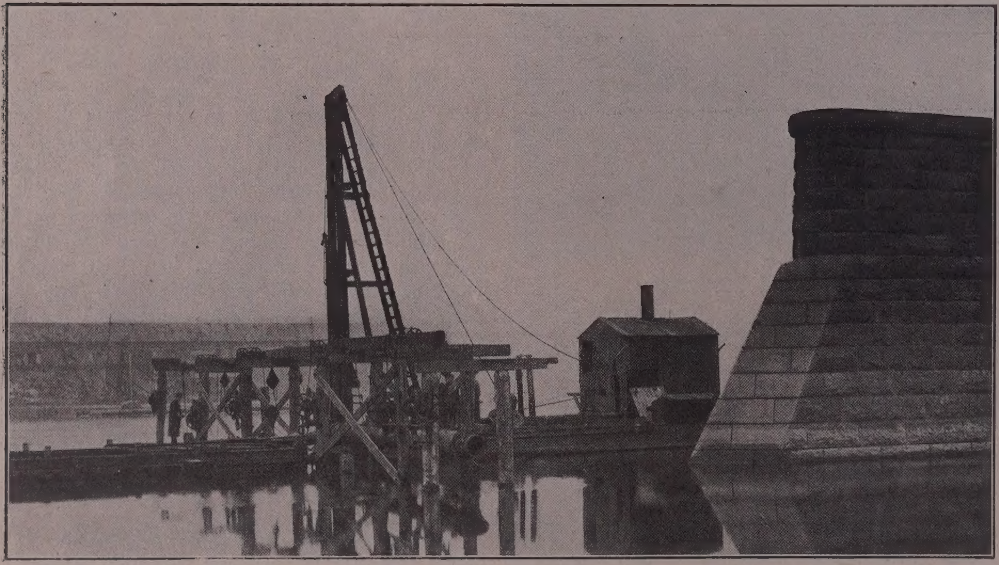
"From a technical standpoint, this test would probably not be considered a very great success, as, first from a point of economy of design, it might be criticized because of placing the beam concentration in the center of the girder instead of on the third points, but as we desired to secure a slab of fair span and still not increase the size of the panel to too great an extent, we found this necessary. Also, the method of loading with bags of sand is in this case as it always has been, open to objections because of its arching action and an attempt was made to break the arch by passing timbers through both ways, but the deflections show very clearly that this arch action existed to some extent.

"The T section calculated throughout has been assumed as being 2 ft. in width, as practical experience has shown this to be conservative because of the old fault of misplacing floor reinforcement. For instance, should the span of the slab be of any great length and the steel setters neglect to carry the slab rods to the top of the slab over the beam, which is a very common neglect, and this slab then be loaded so that it deflects ever so slightly, you will, of necessity, find cracks running in the direction of the beam and about 6 in. out from its edge, thus in practice limiting you to a 2-ft. T section, that is 12-in. for the stem of the beam and 6 in. out on each side to the imaginary crack."

REPAIRING A SUBMERGED WATER MAIN.

SIR: In repairing a 16-in. water main under the Mississippi, at St. Paul, Geo. W. Oakes & Co., of that city, have recently completed a contract with the Water Board which involved some unusual engineering problems. The work was accomplished by splintering the main with dynamite, raising 112 feet of it by block and tackle while new lengths of pipe were added, and lowering the whole to be fastened to the shore end of the pipe by divers.

The main extends under the river about 13 ft. below the surface, on a line with Broadway and had been out of service two years on account of a break which permitted 20 per cent. of the water to escape. Two efforts to repair the break with sleeves had been unsuccessful when Oakes & Co. contracted to repair it in January, 1907. They put in a cofferdam during the winter and were ready to work on the main when an early thaw sent the ice against the workings and everything was washed out. It was not until last September that a new contract was made, under which the work was completed.

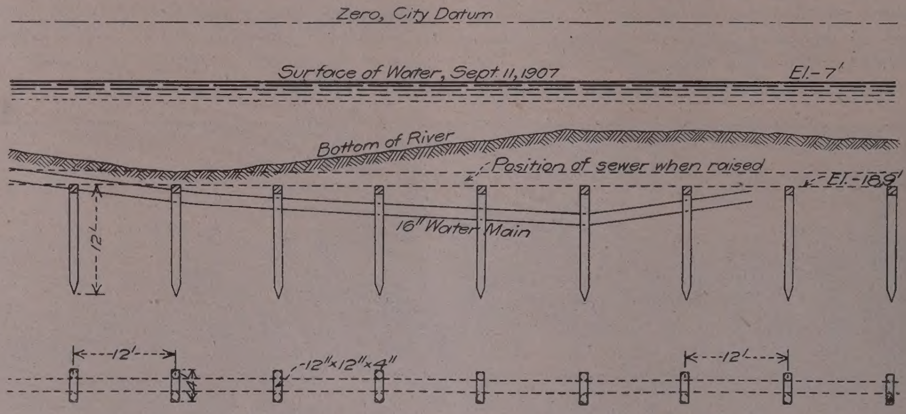


Temporary Bents with a Part of the Water Main Raised.

The break in the pipe was at a joint about 100 ft. from the west shore of the river. The pipe here was covered with about 10 ft. of sand and driftwood in addition to 9 ft. of water. When the cofferdam was washed out the bed of the river was scoured so that the main then dropped several feet below its former position. Logs and bark from the upper river were washed in with the sand which covered the pipe. The pipe was in all cases 10 ft. below the surface of the water although the amount of sand over the pipe varied from 2 to 9 ft.

It was decided not to use a cofferdam on the second attempt, but to uncover the pipe, bring the broken part to the surface, put in new lengths and make the connection by divers. With a Morris 8-in. centrifugal direct-connected sand pump on a scow, 160 ft. of the main was uncovered. Because of the depth at which the pipe lay below the bed of the river, considerable additional sand had to be removed for slopes on either side and some trouble was experienced with logs and bark clogging the pipe. The sand was discharged some distance down stream. A month and a half was occupied in this dredging.

After the dredging was completed, six bents of temporary piles were driven, the piles straddling the pipe 6 ft. apart. The bents were separated 24 ft. and extended 8 ft. above water. These bents were equipped with crabs and tackle and were used to lift the end of the main above water for repairs. At the same time there were also driven the piles on which the repaired main was to rest. A bent of piles was driven for each length of pipe, straddling the main 4 ft. apart. These were cut off by a circular saw on a shaft driven by a belt from the engine and lowered on a frame from the pile driver. The piles were capped by 12 x 12-in. timbers on which cleats were nailed to prevent lateral movement of the main when in position.



Relative Positions of Broken and Repaired Water Main.

The main was laid twenty years ago with alternate bell and ball joints, the latter located every 27 ft. As these permitted a turning of only 17 deg., it was necessary to use the second ball joint to get the pipe above water. A diver fastened chains under the pipe, in line with the temporary bents, and over a hundred feet of pipe was raised, 54 ft. being on the incline from the main to the surface of the river and 62 ft. above water, to which 12 ft. additional were added to replace the part broken. This additional pipe, together with the labor of making the joints above water, was furnished by the Water Board.

When the repaired main was ready to be lowered onto the supporting piles it was found that a length of pipe on the shore end of the main was also cracked, which delayed work several weeks. After examination, a diver cut the cracked section close to a ball joint. Because of the lead filling in the joint it was impossible to open it.

The cutting under water was rather novel. The pipe was marked with a pipe cutter in the hands of the diver, who then bored several ¾-in. holes with a ratchet in the pipe, which was an inch thick. In the holes he inserted drifts and neatly split the pipe along the marking.

The 128 ft. of pipe suspended on the bents was lowered to measure for the additional short section, raised and the pipe caulked. Meanwhile, the lower half of the sleeve had been placed in position and the end of the pipe under water supported by jacks. The long section of main was then again lowered on the piles and the sleeve bolted on by a diver.

Water was turned on three months after operations were commenced, and although there is a slight leak somewhere, it is not near the recent repaired section.

The temporary piles were removed, as they were placed, with the help of hydraulic jets, and the main covered with two feet of sand. Previous experience with the main during the twenty years had shown that the changing currents in the river were liable to wash the sand from beneath the main, so piles 12 ft. long were driven into the bed of the river as a support against such contingency.

St. Paul, Jan. 21. HERBERT H. SMITH.

A COMMERCIAL MOTOR WAGON SERVICE is employed by the "Eastern Daily Press," an English newspaper, in distributing its papers at more than a hundred towns and villages in West Norfolk, the car leaving Norwich daily at 2.30 o'clock in the morning. Between Jan. 3 and Nov. 30, 1907, this car ran more than 25,000 miles. Out of a possible 284 journeys, 275 successful trips were made, a percentage of 96.83. Of the nine unsuccessful journeys, on three days complete failure was due to fog, on three other days fog caused a partial failure of the service. On two occasions tires caused a partial failure of the service, and on one trip partial failure was due to chain trouble. Between Feb. 13 and Oct. 8 the record was absolutely clear. The distance traveled, and the percentage of successful days, afford proof of the good work that may be got out of commercial cars. The service was inaugurated about five years ago. A Siddeley car is used.